POWER

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On Being a Good Loser

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IT IS not given to every engineer to advance steadily in his profession without setbacks which at times wear a discouraging aspect. The power to take the long look forward, to be a good loser if one is temporarily held back, and to learn the utmost possible from apparent failures is almost invaluable. Take the matter of promotions. Sometimes a plant chief resigns or passes away, leaving a second in command who feels himself the logical successor, and along comes the plant owner with a new man for the post of command, or, harder than this, he appoints a younger man from below in the organization in place of the former chief. Experiences like these put upon the "heir apparent" to the chief engineership a strain which sometimes causes him to offer his resignation at once in the belief that he is no longer appreciated and that the future in this particular station holds nothing for him.

THE GOOD loser in a situation of this kind conceals his feelings at least for the time being and never makes the mistake of jumping too rapidly to conclusions. His disappointment at being blocked in his logical progress may be taken for granted; but instead of losing his temper and acting hastily, he immediately begins a personal stock-taking. The problem is to find the reason why someone else was called to "go up higher," and the man who can analyze a situation of this kind regardless of how hard it may hit himself is at least fortunate in being able to look facts in the face. Now there may be a hundred reasons why he was not selected to command the installation. Some of them haven't the slightest relation to his personal efficiency. Cases are not unknown where an unfair choice is made through favoritism, family connections, misunderstanding of the inside situation, or some other cause beyond the control of the engineer. What concerns *him* is his own record in the plant, his own fitness for larger responsibilities.

NOTE the course of the good loser. He subjects his work to a severity of scrutiny which is bound to bring out every weakness of performance and, in most cases, every important lack in qualifications. Rigid self-examination helps mightily to establish the true inwardness of the new appointment. Then the engineer begins to study the ways and knowledge of his new chief and seeks to learn what he can from him to improve his own efficiency. His loyal service continues. Time passes, and ultimately the truth comes home to him. If the superiority of the new chief is established in his mind—and it takes pluck to realize it—the good loser may decide to continue in his present post, striving constantly to do better work and attain a broader mastery of his profession. On the other hand, he may become convinced that better opportunities lie elsewhere, and quietly but deliberately may begin to lay his plans to become established in another installation. Whatever the decision, it is not hasty, and it is the outcome of mature study which not seldom points the way toward more efficient service. Personal "preparedness" often grows out of difficult and trying situations in connection with the organization and direction of power-plant personnel. And it should not be forgotten that sometimes the new chief proves less adapted to command than the good loser, whose fitness is demonstrated thereby and who may come into his own by refraining from rash generalizations while sticking harder than ever to his job.

Walnut Plant, Columbus Railway, Power and Light Co.

This plant is ten miles from the center of the city and will have a capacity of 31,250 kv.-a. The boilers are arranged on the unit system, each unit consisting of two boilers, one economizer, two stokers, one induced- and one forced-draft fan. No bypasses are provided for the economizers. Each unit is to operate continuously or shut down as a whole when necessary. With three exceptions auxiliaries are electrically operated. All equipment requiring attention is on the main-floor level. The circulating and condensate pumps are of the vertical motor-driven type.

THE Columbus Railway, Power and Light Co. operates the street cars and supplies light and power for the City of Columbus, Ohio, its surrounding suburbs and near-by villages. This company has a number of old power stations, some of which are becoming inoperative due to one reason or another. The company still owns the site and buildings that were used for the first commercial generating station built in Columbus, and the first Edison station, started nearly thirty years ago, is still in operating shape and used considerably at times. For a number of years the company has had plans under consideration for new power-plant equipment, and in the last two years this problem became extremely active owing to the large increase in the industrial load and to the necessity of securing more economical operation.

Because of the scarcity and quality of water for condensing purposes and the lack of space for coal storage, it was considered desirable to find a site for a new power station outside of the city. The location chosen is ten miles southeast of the center of the city at a point where the Hocking Valley Ry. crosses Big Walnut Creek. The site consists of 25 acres of rolling ground on the east bank of Walnut Creek, with the railroad running through about the center of the property. The map of the property, Fig. 15, shows the location of the plant and the railroad tracks for coal-storage purposes and proposed operators' houses. Big Walnut Creek is formed by three small streams that come together about a mile above the site of this plant. There are approximately 500 square miles in the watershed of Big Walnut above the plant site, and there is a natural pool in the creek at the station varying in depth at low water from 15 to 20 feet.

The plant, Fig. 1, is located on the north half of the property, the low ground of this part being used for coal storage and the other part for houses for the operators and for coal storage. It will be the policy of the company to carry sufficient coal in storage, when it can be obtained, to run the plant for three or four months at a time.

The site for the Walnut Station was purchased in January, 1917. Active work was started in April, and the station began regular operation Nov. 18, 1917. This was accomplished in spite of delays in nearly all shipments of equipment and in the midst of a difficult labor market.

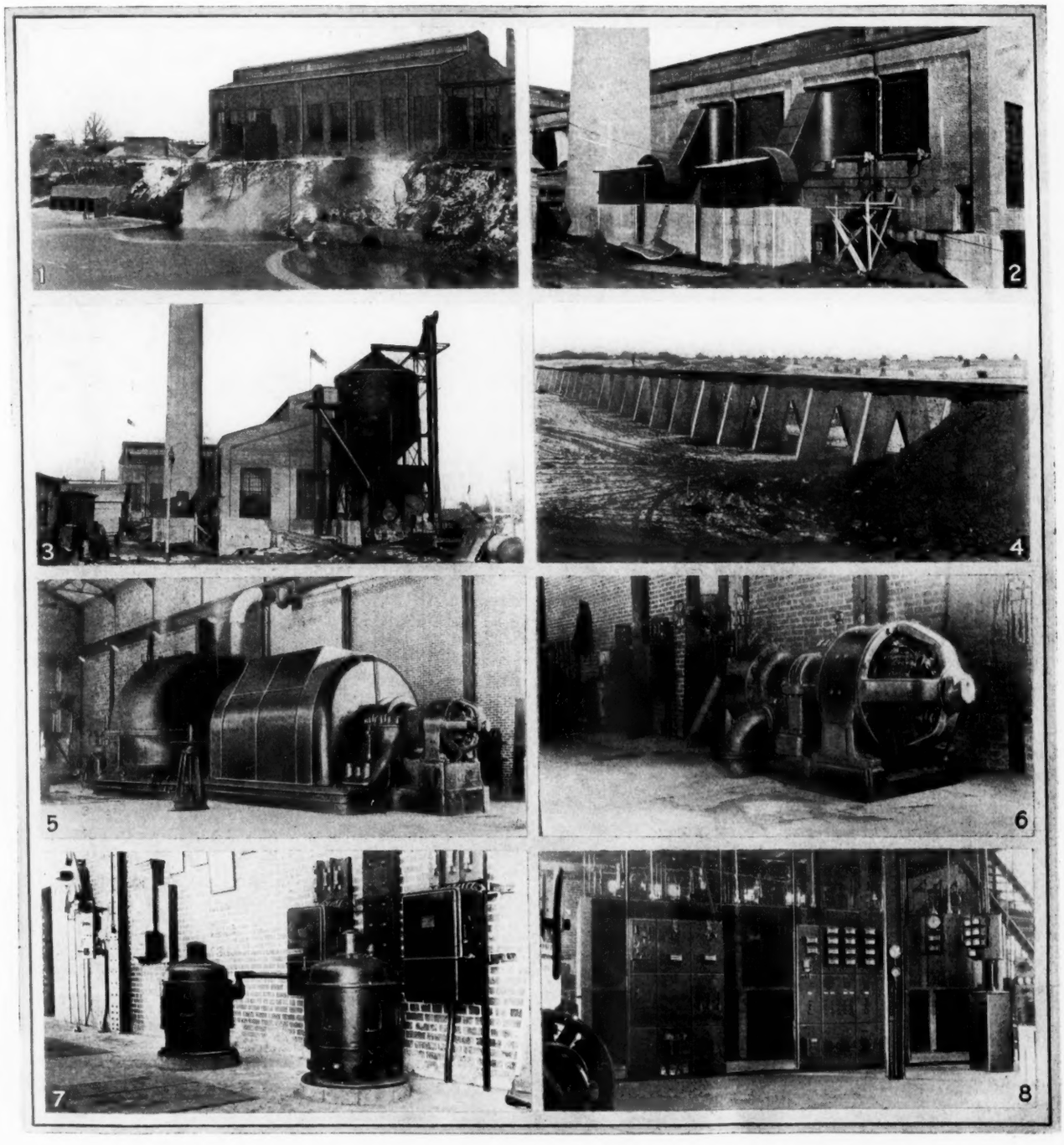
That part of the station now in operation consists principally of one 18,750-kv.-a. 60-cycle turbine, Fig. 5, and eight 440-hp. boilers provided with underfeed stokers. The plans include a second turbine, capacity 12,500 kv.-a. and eight additional boilers. This equipment is under order, and it is expected that it will be ready for installation in the early part of 1918. Fig. 9 is a plan view of the completed plant.

The boiler plant will consist of 16 cross-drum water-tube boilers, each having a heating surface of 4440 sq.ft. The present boiler and turbine installation gives 1.9 kw. turbine capacity per square foot of boiler-heating surface. With the second turbine and eight additional boilers there will be a ratio of 1 sq.ft. of boiler-heating surface to 2.27 kw. of turbine capacity. Each boiler has 21 sections of tubes, each section consisting of 10 tubes 18 ft. long and 4 in. diameter. Single-loop superheaters are also provided, each having 855 sq.ft. of heating surface, which will give about 150 deg. superheat under average conditions. This gives a ratio of 5.19 sq.ft. of boiler-heating surface to 1 sq.ft. of superheater surface. These boilers are designed for 250 lb. steam pressure and are provided with mechanical soot blowers, feed-water regulators, balanced-draft regulators for opening the outlet dampers and with furnace meters which record the steam flow, air flow through boilers and the temperature of the exhaust gases and also indicate the draft under the stokers.

The boilers are set two in a battery, and each boiler is provided with one 8-retort underfeed stoker. The gases from each battery of boilers pass through one economizer having 6300 sq.ft. of heating surface, or 1.4 sq.ft. of boiler-heating surface per square foot of economizer surface. Each economizer has 32 sections, each section consisting of 12 tubes, 12 ft. long and $4\frac{5}{8}$ in. outside diameter. The gases are conveyed from the boiler to the economizer by means of $\frac{5}{16}$-in. steel-plate flues covered with $1\frac{1}{2}$ in. of asbestos. The gases from each economizer are in turn conveyed from the economizer by uncovered steel breechings to one 60,000-cu.ft. per min. induced-draft fan, Figs. 2 and 9. These fans are direct-connected to 75-hp. variable-speed motors. The fans discharge downward into a concrete flue, located below grade, which connects into the base of a tapered concrete chimney having a height of 150 ft. and an inside diameter at the top of 14 ft. 6 in. There will be two of these chimneys, one chimney accommodating four fans and eight boilers. The economizers are provided with the usual scraper mechanism, and one 5-hp. 720-r.p.m. motor drives the scrapers on two economizers.

It should be noted that the boilers are arranged in units of two boilers, one economizer, two stokers, one induced-draft fan, one forced-draft fan, and that no bypasses are provided for the economizer. It is expected to operate this unit continuously and when necessary to make extensive repairs, to shut down the

entire unit. Of course either one of the boilers may be shut down for cleaning without disturbing the operation of the other. The stoker, forced- and induced-draft fans are all driven by motors, the controllers for variable-speed motors, which are hand-controlled. The forced draft is also hand-regulated by varying the speed of the motors and by the movement of the dampers in the air ducts.



FIGS. 1 TO 8. GENERAL VIEWS IN AND ABOUT THE NEW POWER PLANT

Fig. 1—View of turbine room from river side, showing intake- and discharge-water tunnels, feed-water purifying plant and a portion of outdoor 39,400-volt bus structure. Fig. 2—Showing induced-draft fans for boilers 1 and 4 and openings in walls for economizers. Fig. 3—General view of plant from boiler room, showing coal- and ash-handling equipment, induced-draft fans and concrete stack. Fig. 4—Coal-storage track. This track showing elevated steel support track mounted on concrete piers. Fig. 5—The 18,750-kv.-a. turbine, showing generator end at the right with direct-connected exciter and main steam pipe for turbine. Fig. 6—The 100-kw. turbo-exciter set. Fig. 7—Two 35-hp. 220-volt, three-phase, alternating-current vertical constant-speed motors with controllers for driving condensate pumps. Fig. 8—General view of switchboard panels and bus structure; the panels at the left are for control of exciter, panels in the center are for control of outgoing lines and pedestal at the right controls turbine.

which are located convenient to the boilers and are under the control of the boiler-room operators.

The balanced-draft equipment will provide the close regulation of the induced draft, and the large steps in the adjustment of this draft are obtained by the

The economizers are operated in parallel and feed direct into the feed-water header, and to avoid unequal feeding from the economizers there are monel-metal orifices in the feed-water header between the connections to the economizers, the feed-water branch pipe to each boiler

connecting to the header at a point between the orifices. As for the fine adjustment of the feed to the economizers, it is expected to obtain this by regulating the opening of the valves in the connections between the economizers and the header, determining the adjustment of these valves by the temperature of the feed water leaving the economizers, as shown by recording thermometers. In addition to the recording furnace meters, there are recording thermometers for the gases leaving the economizers and for the water entering and leaving the economizers and also for the water entering the feed-water heater. Fig. 11 is a cross-section of the boiler room.

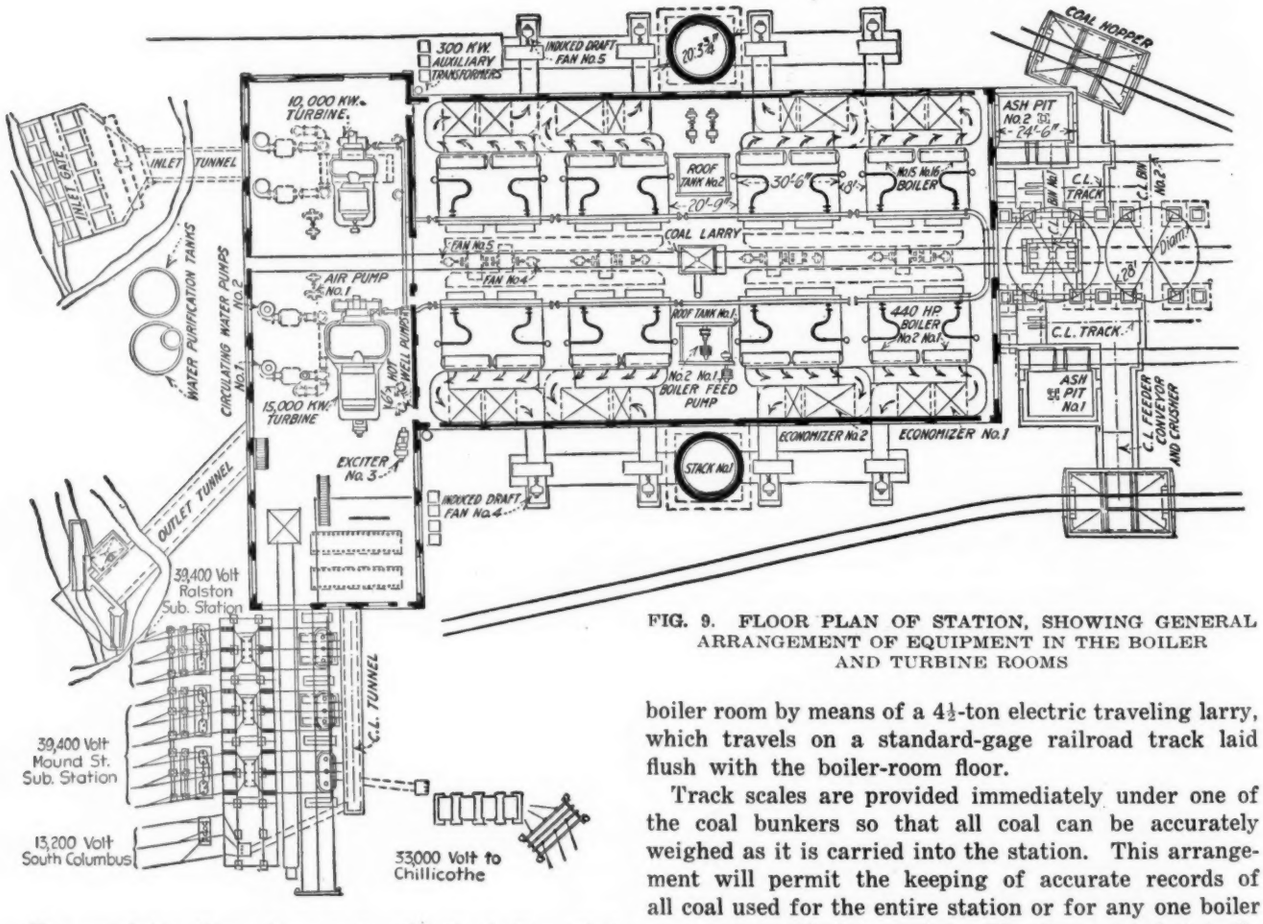


FIG. 9. FLOOR PLAN OF STATION, SHOWING GENERAL ARRANGEMENT OF EQUIPMENT IN THE BOILER AND TURBINE ROOMS

For supplying the makeup water for the boilers, that is, water over and above that secured from the surface condensers, a lime and soda-ash feed-water purifying plant is installed. It is placed outside of the building, as shown in Fig. 1. This plant consists principally of two 20,000-gal. wood-stave tanks with stirring mechanism, and an elevated dosing tank. The river water is of fairly good quality except during high water, when it may be quite roily.

Four 4-stage centrifugal pumps supply the boilers with water. Three are motor- and the other one is turbine-driven. The water rate of the turbine at full load is 49 lb. per brake-horsepower.

The steam from the boilers will be carried through 6-in. steam lines to a main 12-in. steam header. Each row of eight boilers will be provided with a 12-in. steam header, the two headers being connected together at each end so as to form a ring. In the same way the feed water will be supplied to the boilers from a 6-in. feed-water header for each row of boilers, and the feed-water headers will be connected across so as to form a loop.

The equipment for handling the coal and ash is very complete. The station will be provided, when completed, with two 400-ton coal bunkers located just outside of the boiler room at the end of the station, Figs. 3 and 13. Coal will be supplied to these bunkers from two track hoppers, the coal passing from the track hoppers by means of a flight conveyor through a coal crusher and thence by bucket elevator to the top of the coal bunkers. The coal from the bunkers will be carried into the boiler room by means of a 4½-ton electric traveling larry, which travels on a standard-gage railroad track laid flush with the boiler-room floor.

Track scales are provided immediately under one of the coal bunkers so that all coal can be accurately weighed as it is carried into the station. This arrangement will permit the keeping of accurate records of all coal used for the entire station or for any one boiler over any particular period. The larry is electrically operated, has a revolving bin which works like a turret, and is provided with a screw conveyor which supplies the boilers on either side of the firing aisle. The larry requires only one man for its operation, is simple in construction, and all wearing parts are accessible for repairs.

The foundations for the boilers are of concrete and form the ashpits. Two drag-chain conveyors pass under each row of eight boilers, conveying the ash out to the end of the station and discharging into a clinker crusher, which in turn discharges into the boot of a bucket elevator. This elevator may discharge either into a concrete ashpit, shown at the right of Fig. 9, or into railroad car or wagon. The ash can be disposed of for a long time by grading around the property. Each drag-chain conveyor has sufficient capacity for carrying out the ash, and duplicate con-

veyors are furnished so as to allow repairs and changes to be made without inconvenience to operation, as arrangements are made so that either one can be isolated for repairs without interfering with the other.

The coal will be distributed over the ground and reloaded into cars for moving into the station by means of a 15-ton steam-driven locomotive crane provided with a 2-yd. grab-bucket.

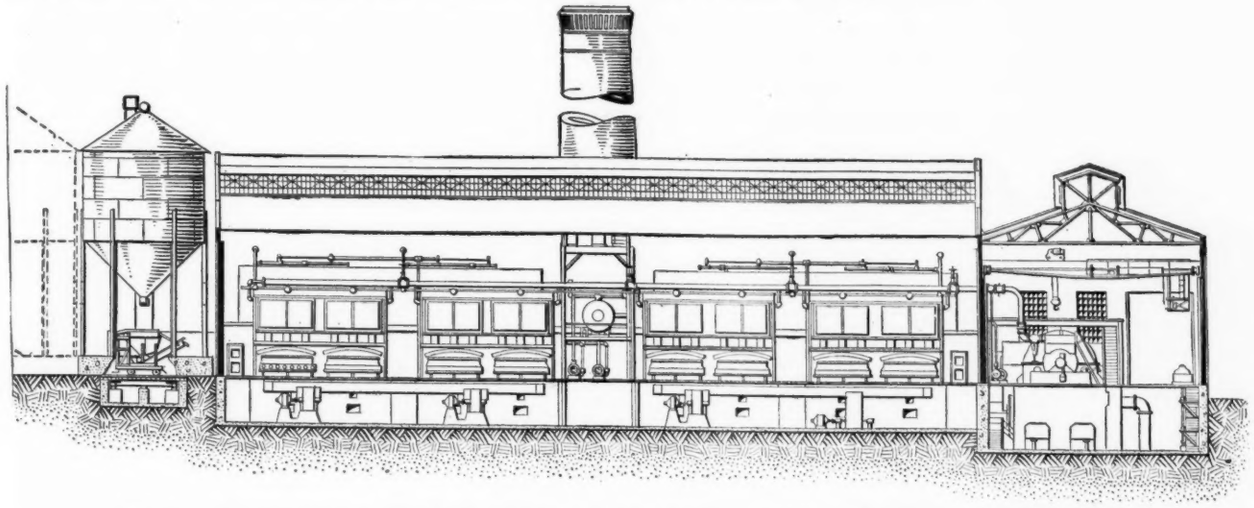


FIG. 10. LONGITUDINAL SECTION OF BOILER ROOM AND A CROSS-SECTION OF TURBINE ROOM

The coal bunkers have capacity sufficient for one to two days' operation of the station. To provide against car shortage and irregularity of shipments, an elevated storage track is provided, a track 480 ft. in length being elevated approximately 15 ft. over low ground, Fig. 4. Since practically all the coal received is in hopper-bottomed cars of one type or another, no labor will be required for unloading them. This track is supported by reinforced-concrete piers, 14-ft. centers, and supported between piers by steel I-beams with steel cross-members on 5-ft. centers to prevent spreading.

The generators are connected to the 13,200-volt bus through oil switches, and a transfer bus is provided with a transfer switch so that any 13,200-volt switch with its instrument transformers may be cut out of service and worked on when necessary without interrupting service. All feeders and other circuits are provided with the same type of oil switch, and all of them are remote-controlled from the switchboard. All the turbine controls are also located at the switchboard.

The auxiliaries in the station will be electrically operated with the exception of one boiler-feed pump

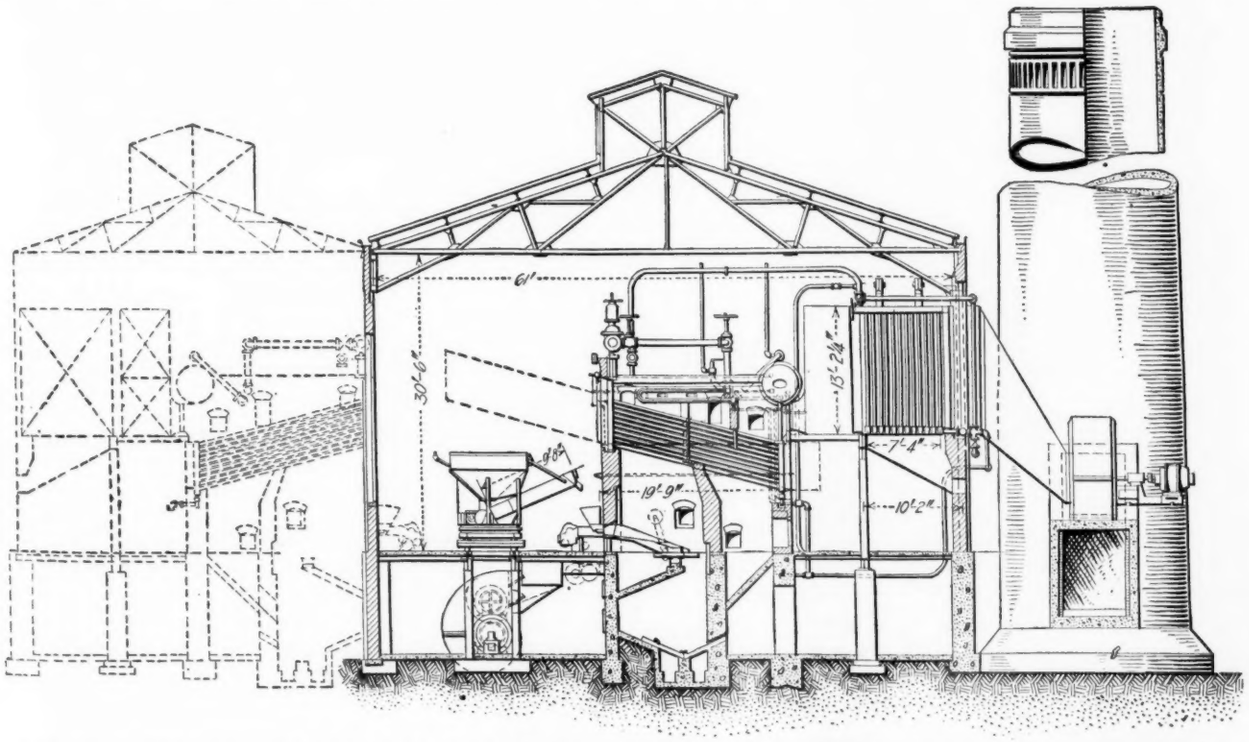


FIG. 11. CROSS-SECTION OF BOILER HOUSE, SHOWING PRESENT AND FUTURE BOILER ROOM AND ARRANGEMENT OF FORCED DRAFT, STOKERS, FLUES, ECONOMIZERS, ETC.

and two dry-vacuum pumps. The current for supplying these motor-driven auxiliaries will be supplied by two duplicate banks of three 300-kv.-a. single-phase 13,200-volt to 220-volt outdoor type self-cooled transformers. The total connected load of motors for auxiliaries in the station will amount to 2533 hp.

Each turbine is provided with a direct-connected 100-kw. 250-volt exciter, and a 100-kw. 3600-r.p.m. geared turbo-exciter set is provided for spare service, Fig. 6.

The plant is laid out with the idea of having all equipment that requires attention on the main-floor level, or elevation 740, this applying to the switchboard, turbines, motors for driving circulating water pumps and hotwell pumps, controllers for all forced-draft, induced-draft and stoker drives, battery-charging set, etc. Therefore there will be as small occasion as possible for the operators leaving the main floor.

Each turbine is provided with a surface condenser, and each condenser will be supplied with circulating water by duplicate vertical variable-speed motor-driven circulating-water pumps. These pumps, Fig. 12, receive water from a gravity tunnel which runs under the length of the turbine room, and the water from the condensers discharges into another separate gravity tunnel, which also runs the full length of the turbine room and carries the water out into the river at a point about 160 ft. below the intake. Each condenser is also provided with duplicate vertical motor-driven single-stage centrifugal condensate water pumps, Fig. 7. Therefore, by the supplying of these duplicate sets of circulating water and hotwell pumps it is possible to avoid many reasons for shutdown.

The circulating water being carried into the station by a concrete tunnel and in turn being carried out by the same means, eliminates the usual large amount of piping required for circulating water and also supplies the water at a convenient point with minimum waste of power. The water in the tunnel will have a velocity of about 2 ft. per sec. with two turbines carrying full load and about 3.1 ft. per sec. with 40,000-kw. turbine capacity in operation. The discharge-water lines from the condensers are sealed in the discharge tunnel so that advantage is taken of the siphon action obtained thereby.

The intake end of the tunnel is enlarged and provided with a large area of racks (velocity through racks 0.5 ft. per sec. first two units and 0.8 ft. per sec. for 40,000 kw. of turbines in operation) for the water to flow through. There are also provided six large removable wire baskets (1-in. mesh) which should catch nearly all the leaves, twigs, etc., that may come downstream during high water. Each basket is in a separate compartment provided with a gate for shutting off the flow of water when the basket is raised for cleaning. A traveling hoist is provided for operating the gates and baskets. Such particles of leaves, twigs, etc., as pass through these baskets and racks can be removed before reaching the condenser by means of twin strainers ($\frac{3}{8}$-in. holes) which are located between the circulating-water pumps and the condensers. The circulating-water pumps are immediately on top of the

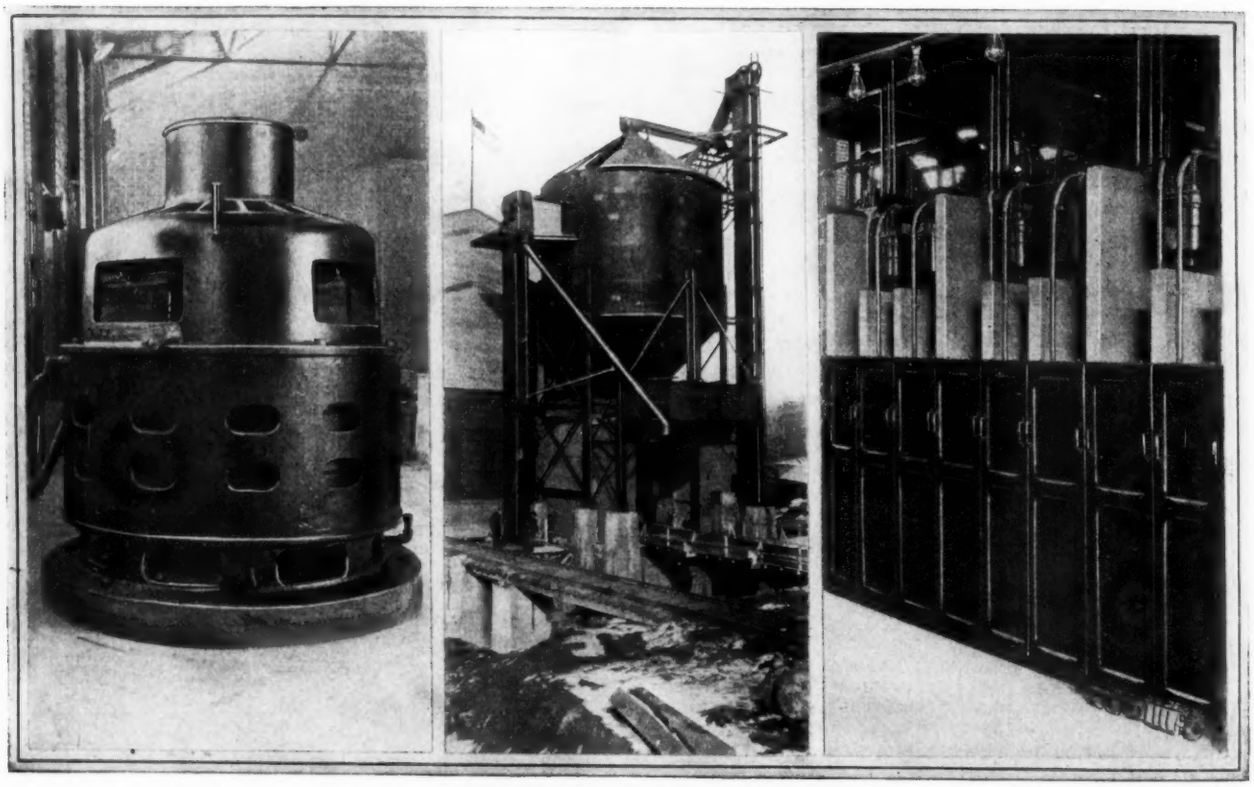


FIG. 12. A 120-HP. VERTICAL VARIABLE-SPEED, 220-VOLT, THREE-PHASE, ALTERNATING-CURRENT MOTOR FOR DRIVING ONE OF THE CIRCULATING WATER PUMPS

FIG. 13. VIEW OF COAL BUNKER AND ASH ELEVATOR. THE ELEVATOR AT THE LEFT WITH THE LONG CHUTE HANDLES THE ASH

FIG. 14. A PORTION OF 13,200-VOLT SWITCH CELLS, SHOWING LOCATION OF POTENTIAL TRANSFORMERS. DISCONNECTING SWITCHES ARE BACK OF THE REMOVABLE DOORS

intake tunnel so that a minimum suction lift of about 11 ft. is secured.

A battery of four 200-gal. per min. motor-driven centrifugal pumps is located in the basement of the turbine room for furnishing water to the feed-water purification plant, for the cooling of bearings and for the 15,000-kv.-a. transformers.

The condenser of the 18,750-kv.-a. unit is bolted direct to the exhaust flange of the turbine without any expansion joint, Fig. 16. Car springs are placed below the condenser and so compressed as to balance the weight of the empty condenser. These springs will allow the condenser to expand when heated, and the

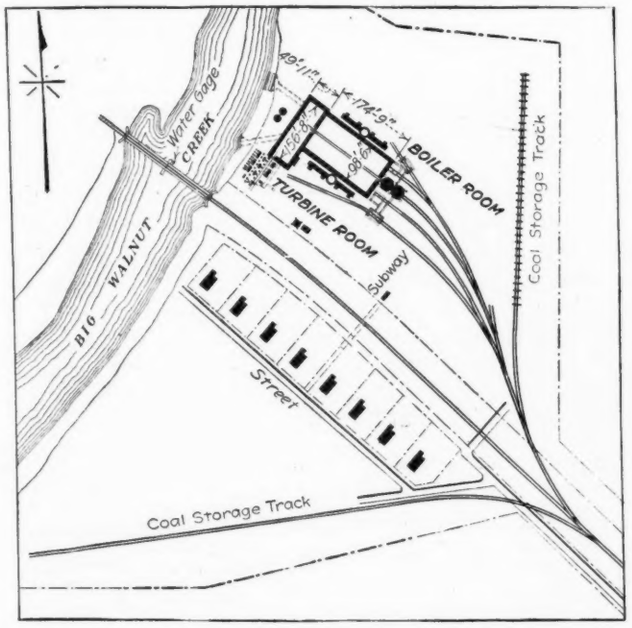


FIG. 15. PROPERTY MAP SHOWING GENERAL ARRANGEMENT OF TRACKS AND LOCATION OF PLANT, COAL STORAGE AND OPERATORS' HOUSES

turbine is capable of taking the additional weight of the water which may be in the condenser during regular operation.

The condensate from the condenser is forced by the centrifugal pumps to the top of the boiler room, where the water will flow through water meters into an open storage tank. This tank is divided into two compartments, one compartment with a capacity of 6000 gal. for condensate and one compartment with a capacity of 3000 gal. for makeup water. The water from this storage tank will flow through an open feed-water heater having 1300 sq.ft. of heating surface. The feed-water heater is divided into two parts; the condensate will pass over one-third and the makeup water over two-thirds of the heating surface. From the heater the water will pass through a battery of four 400-gal. per min. four-stage centrifugal boiler-feed pumps, three of these pumps being driven by 100-hp. three-phase 60-cycle 220-volt 1740-r.p.m. motors, and the fourth by a steam turbine, 1850 r.p.m. The pumps will discharge direct into headers supplying the economizers, the economizers carrying full boiler pressure plus the additional pressure required for forcing the water through the economizer to the boilers.

As the station is situated about ten miles from the center of distribution of the current in Columbus, it was thought desirable to transmit at a higher voltage than that generated. Therefore the current will be carried into the city over three transmission-line circuits at 39,400 volts, and one 13,200-volt circuit, the latter being the generating voltage, which will feed an industrial section at the extreme south end of the city. The electrical energy will be received at 39,400 volts at one point in the city at the present time and at second and third points later on. Current will be distributed in the city between substations and to large power customers at 13,200 volts; the primary voltage for all other light and power customers is 4150 volts four-wire distribution. The tie-lines between the prin-

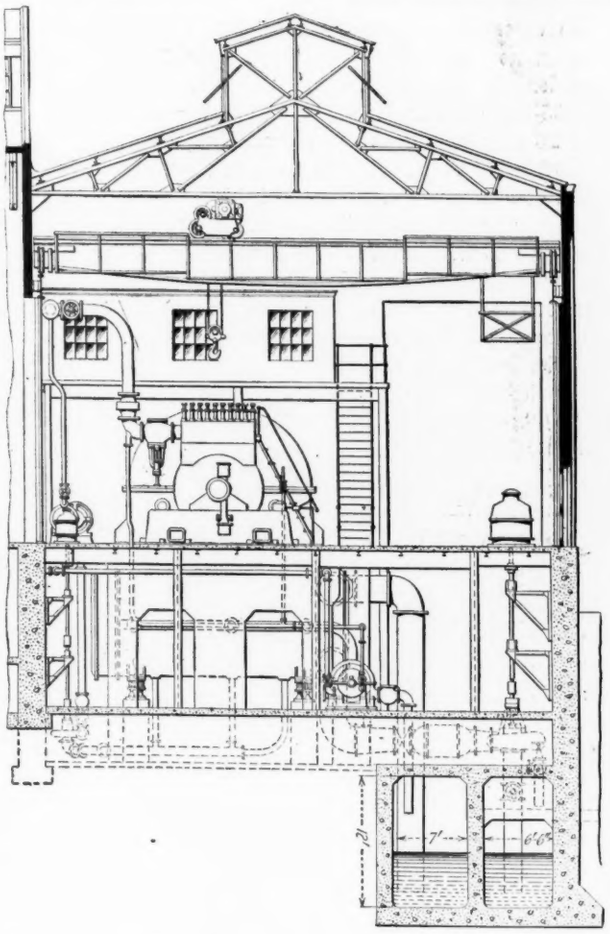


FIG. 16. CROSS-SECTION OF TURBINE ROOM, SHOWING SOME OF THE DETAILED ARRANGEMENT OF CONDENSING EQUIPMENT FOR THE TURBINE. ALSO SECTION OF WATER TUNNELS FOR CIRCULATING WATER

cipal substations of the city will operate at 13,200 volts and consist of triple-conductor lead-incased cables laid in vitrified-clay duct subways. Figs. 8 and 14 show the switchboard panels and a portion of the 13,200-volt switch cells respectively.

The current will be transformed from 13,200 to 39,400 volts at the power station by means of 15,000-kv.-a. three-phase 60-cycle water-cooled outdoor-type transformers. Two units will be installed this year and a third transformer at a later date. All switches for the 13,200-volt transformers and main generators will be located within the station, but all the 39,400-volt switches, lightning arresters and connections will be out-

side of the station. Provision is made for taking the transformers in the station on a truck so that they can be placed under the electrical traveling crane for disassembly for repairs and also for the original erection.

Very little space is required within the station for the electrical equipment. The control part is compact and only the 13,200-volt switches are within the station. All transformers, high-voltage bus structure, main-line switches and lightning arresters are located outdoors. Any of this equipment can be cut out of service and moved into the station for inspection and repairs, thus securing all the advantages of the outdoor-type of electrical equipment with minimum disadvantages.

The main building is a steel-frame structure supported on a reinforced-concrete foundation. The turbine room now completed for two turbines is 156 ft. 6 in. in length and 44 ft. 1 in. in width, is provided with a 35-ton electric traveling crane having a rail height of 25 ft. above the main floor. The turbine-room basement is 15 ft. high from floor to floor excepting under the condensers, where the height is 20 ft. The boiler room now completed is 174 ft. in length and 60 ft. in width and will be 174 ft. in length and 96 ft. 2 in. wide when completed for 16 boilers. The height under the lower chord of roof trusses is 30 ft. 6 in. The basement under the boiler room is 10 ft. 6 in. floor to floor.

The outside walls are built of hard-burned red brick, and the partition and temporary end walls of the turbine room are built of interlocking tile. Fenestra steel sash glazed with factory-ribbed glass are used throughout the building. Steel rolling doors are used for large doorways and steel paneled doors on all small doorways.

The roofs are supported by Fink trusses, $\frac{1}{3}$ pitch, provided with monitors, ventilation being secured by opening sections of the steel sash by means of suitable window-operating mechanism. The roof for the boiler room consists of a concrete slab waterproofed with three-ply asbestos felt laid in asphalt. The turbine-room roof is similar except that a slab made up of a composition of gypsum and wood fiber is used, this construction being resorted to in order to avoid the possibility of condensation forming on the underside of the roof. The concrete slabs for roof and floors are supported by asbestos-protected corrugated metal with reinforcing fabric. The slabs are flat in both cases, being $2\frac{1}{4}$ in. thick for the roof and 4 in. for the floor.

The foundations for walls and equipment are supported on reinforced mats or footings which rest on hard river gravel or clay hardpan, the character of earth varying according to the elevation of the various foundations. Extensive soundings and test pits were driven to determine the nature of underlying earth previous to starting construction. A test pile was also driven in the deepest portion of excavation.

For the foregoing information and accompanying illustrations, *Power* is indebted to the E. W. Clark & Co. Management Corporation, who designed and constructed the Walnut Station.

PRINCIPAL EQUIPMENT OF THE PRESENT BIG WALNUT CREEK POWER PLANT, COLUMBUS, OHIO

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
8	Boilers	Water-tube	4,440 sq.ft. heating surface	Main steam generators	250-lb. steam, 150 deg. superheat	Babcock & Wilcox Co.
8	Superheaters	Single loop	855 sq.ft. heating surface	With water-tube boilers	150 deg. superheat under normal conditions	Babcock & Wilcox Co.
8	Soot cleaners	Diamond		Cleaning boiler tubes	As conditions demand	Diamond Power Specialty Co.
8	Regulators	Copes	2½-in	Feed-water regulation	Automatic balanced regulating valve	Erie Pump & Equipment Co.
3	Meters	Bailey		Steam flow, air flow, draft	Automatic	Bailey Meter Co.
8	Stokers	Riley, self-dumping	8-retort	With steam boilers	Motor-driven, chain connection	Sanford Riley Stoker Co.
4	Economizers	Green, fuel	6,300 sq.ft. heating surface	One serves four boilers	Under-pressure	Green Fuel Economizer Co.
4	Fans	Induced-draft	60,000 cu.ft. per min	Induced draft to furnaces	Motor-driven, 3-in. pressure, variable speed	Green Fuel Economizer Co.
4	Fans	Forced-draft	45,000 cu.ft. per min	Forced draft to furnaces	Motor-driven, 5½-in. pressure, variable speed	Green Fuel Economizer Co.
1	Fan	Forced-draft	45,000 cu.ft. per min	Forced draft to furnace	Motor-driven, 5½-in. pressure, variable speed	B. F. Sturtevant Co.
4	Motors	Induction	75-hp	Driving forced-draft fans	600 r.p.m., 220-volts, flexible coupling	Lincoln Electric Co.
3	Motors	Induction	75-hp	Driving forced-draft fans	600 r.p.m., 220-volts, flexible coupling	General Electric Co.
1	Motor	Induction	100-hp	Driving forced-draft fan	900 r.p.m., 220-volts, flexible coupling	General Electric Co.
1	Heater	Hoppers		Heating and purifying feed water	One-third heats condensate, two-thirds heats make-up water	Hoppes Mfg. Co.
4	Pumps	Centrifugal, 4-stage	400 gal. per min.	Boiler feed	One motor-, one turbine-driven	Cameron Steam Pump Co.
1	Turbine	Curtis	105-hp	Drives feed pump	1,800 r.p.m. water-rate full load 49 lb. per b.hp	General Electric Co.
3	Motors	Induction	100-hp	Drives feed pumps	1,740 r.p.m., 220-volts, A.C.	General Electric Co.
1	Conveyor	Bucket	50-ton per hr	Coal to bunkers	85 ft. height, speed 250 ft. per min	Jeffrey Mfg. Co.
1	Larry	Traveling	5-ton	Coal from bunkers to stokers	Track speed 400 ft. per min	Jeffrey Mfg. Co.
1	Crusher	Single-roll	24 x 24-in	Crushing coal	Motor belt-driven, 900 r.p.m.	Jeffrey Mfg. Co.
1	Scale	Track	50-ton	Weighing coal	Provided with tare beams and type registering device	Fairbanks Morse Co.
2	Bunkers	Steel, circular	400-ton capacity	Coal storage	Concrete-lined	Jeffrey Mfg. Co.
2	Conveyors	Drag	182 ft., 6 in. centers	Handling ashes	Motor-driven, 20 ft. per min	Jeffrey Mfg. Co.
1	Crusher	Single-roll	18-in	Crushing clinkers	Motor, belt-driven, 40 r.p.m.	Jeffrey Mfg. Co.
1	Crane	Locomotive	15-ton	Reclaiming coal from storage	2-cu.yd. grab bucket, 46-ft. boom	Brown Hoisting Machinery Co.
1	Generator	Turbine	18,750-kv.-a.	Main generating unit	1,800 r.p.m., 13,200 volts, 3-phase, 60 cycles	General Electric Co.
1	Exciter	Turbo-generator	100-kw	Exciting main generator	3600-1200 r.p.m., 250 volts, 250 lbs. steam pressure	General Electric Co.
1	Condenser	Surface, spiroflo	23,900 sq.ft. heating surface	With 18,750-kv.-a. turbine	Performance 180,000 lb. steam per hr., 22,000 g.p.m., 70 deg. water, 1.65 lb. vac	Alberger Pump & Condenser Co.
1	Pump	Centrifugal	No. 10	Vacuum in condenser	Turbine driven	Alberger Pump & Condenser Co.
2	Pumps	Circulating	20-in	Water to condenser	12,500 gal. per min., 425 r.p.m.	R. D. Wood & Co.
1	Pump	Condensate	8-in	Condenser condensate	600 gal. per min., 1,140 r.p.m.	Alberger Pump & Condenser Co.
2	Strainers	Twin	24-in	Straining circulating water	Brass buckets, ¾-in. holes	Elliott Co.
4	Pumps	Centrifugal	200 gal. per min.	Water to feed-water pumps	Motor-driven 1,200 r.p.m.	General Electric Co.
2	Motors	Induction	20-hp	Driving stokers	1,200 r.p.m., 220 volts, gear ratio 4.33 to 1	General Electric Co.
2	Motors	Induction, vertical	120-hp	Driving circulating pump	514 r.p.m., 220 volts, speed range 300 to 500 r.p.m.	General Electric Co.
1	Motor	Induction, vertical	35-hp	Driving condensate pump	1,200 r.p.m., 220 volts	General Electric Co.
1	Motor-generator set	Induction-motor, d.c. generator	35-hp., 15-kw.	Operating coal larry	1,800 r.p.m. motor, 220 volts, generator 125 volts	General Electric Co.
1	Crane	Traveling	35-ton	In turbine room	4 motors, 250 volts, d.c.	Case Crane & Engineering Co.
1	Battery	Storage	10-amp	Control	60-cell, 125 volts	Electric Storage Battery Co.
1	Charging set	Motor-generator	5-kw., 10-hp. motor	Charging storage battery	1,800 r.p.m., 125-170-volt generator, 220-volt motor	General Electric Co.
1	Compressor	Belt-driven	10 x 10-in., 210 cu. ft. per min.	Miscellaneous	235 r.p.m., 125 lb. air pressure	Ingersoll-Rand Co.
	High pressure steam valves, 350-lb. pressure, 800 deg. temperature					Nelson Mfg. Co.
	Water meters for measuring condensate and make-up					Alberger Pump & Condenser Co.
	Transformers, switchboards, all switches and miscellaneous electrical apparatus					General Electric Co.

Rewinding Direct-Current Armatures

By R. THISTLEWHITE

The difficulties of winding armatures are easily overcome if a few general principles are kept in mind. These are given in a very brief form without any technical explanation, it being taken for granted that the statements are correct, and should the reader wish proof of the fact he can refer to any standard work on armature winding and find them.

WHEN an armature is to be rewound, the first thing to do is to count the number of slots in the core and the number of commutator bars, from which can be determined the distribution of the coils. Each coil has two sides, as in Fig. 1. Then (1) if there are one-half as many bars in the commutator as slots in the armature core, there will be only one side of a coil in each slot; (2) if there are as many bars as slots, there will be one side of two different coils in each slot; (3) if there are twice as many bars as slots, there will be one side of four different coils in each slot; (4) if there are three times as many bars as slots, there will be one side of six different coils in each slot. Always keep in mind that for every bar in the commutator there must be a coil in the winding.

As there is only one side of one coil in a slot in No. 1, this winding is known as a single-layer winding. In No. 2 there is one side of two different coils in a slot and the winding is called a two-layer winding. In No. 3 there is one side of four different coils in the same slot, therefore it is termed a four-layer winding. In No. 4 there is one side of six different coils in the same slot, consequently it is known as a six-layer winding.

Determining Spread between Coil Leads Connected to the Commutator

The next operation is to trace from the commutator along a lead to the slot it enters, then stretch a piece of string from the center of this slot to the end of the shaft and mark the bar the string passes over; count from this bar to the bar the lead is connected to, taking notice whether this is to the left or right when facing the commutator, Fig. 2, which shows the throw of the leads to be from 1 to 9 to the left. Now, mark bar 9 and lift up the leads about halfway round the commutator, then with a lamp test from the top lead in bar 9 and find the other end of the coil. Count the bars between these two points, including the two the coil's leads connect to, which will give the spread between leads, and with this information the coils can again be connected up to the commutator as they were originally.

There are two general ways of connecting an armature—parallel and series. In the former the spread between the leads will be one bar; that is, the two ends of the same coil will be found in adjacent bars, while in the latter the spread will vary, depending on the number of field poles in the machine. In four-pole machines the spread will be approximately halfway round the commutator, for a six-pole one-third, etc. In parallel windings the leads can usually both be lifted at the same time; that is, the beginning and ending of the coil, or as they are most commonly spoken of, the bottom and top leads. But in the series winding it is generally practice to place the bottom leads first, which are then covered with about two layers of tape, then the top leads are put down; therefore, when lifting the leads, the top ones would be lifted first. It will also be necessary to stretch the string as before and find the throw of the bottom leads in the same manner as the throw of the top leads was found, and also to observe the direction of the throw.

The distance in bars between the bottom and top leads, counted so as to embrace the bars that the coil

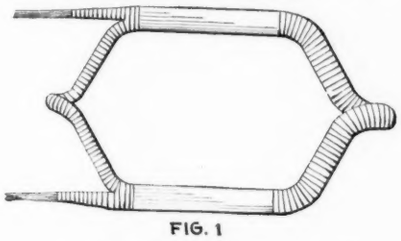


FIG. 1

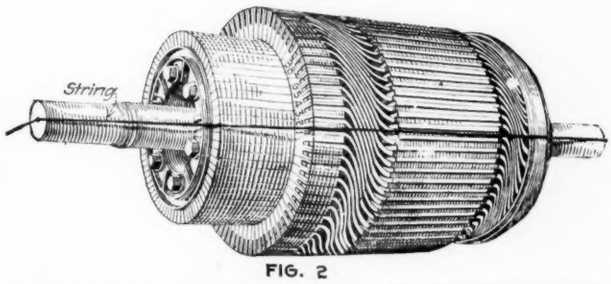


FIG. 2

FIGS. 1 AND 2. ARMATURE COIL AND ARMATURE WITH WINDING CONNECTED TO COMMUTATOR

leads connect to, is the correct count of the lead spread. It will also be found, for a series winding, if the count is continued it will return to the adjacent bar started from. This is clearly indicated in Figs. 3 to 5. Figs. 3 and 4 show one series of coils connected to the commutator of a four-pole machine and Fig. 5 one series of coils connected to the commutator of a six-pole machine. This can be checked by building a short table thus: In Fig. 4 there are 39 commutator bars and for four poles the lead spread should be commutator bars plus or minus 1 divided by the number of pairs of poles; or, in this case, 39 plus 1 equals 40, 40 divided by 2 equals 20, then the coil leads spread bar 1, and bar 1 plus 20 equals 21; that is, the leads of one coil connect to bars 1 and 21. Continuing the count, bar 21 plus 20 equals 41; as there are only 39 bars, bar 40 would be bar 1 and bar 41 would be bar 2, as in the figure. The table will then read 1 and 21, 21 and 2, etc.

Coming back to the foregoing rule and using the minus sign, 39 minus 1 equals 38, 38 divided by 2 equals 19; then the lead spread would be 1 plus 19 equals 20 and 20 plus 19 equals 39, which is adjacent

to bar 1. This is the condition in Fig. 3. The only difference between the connections in Figs. 3 and 4 is that with the motor connected to the line the same in both cases, the direction of rotation of the armature, when the minus sign is used, will be the reverse of that when the plus sign is used.

In the six-pole machine the spread of the leads would be equal to the number of commutator bars plus or minus 1 divided by the number of pairs of poles; in this case three counts have to be made before a series of coils encircle the commutator as in Fig. 5.

When the lead spread has been taken and checked, the armature can be stripped and the number of turns

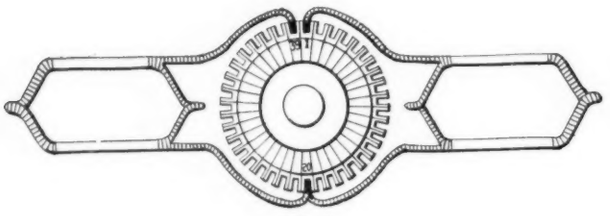


FIG. 3

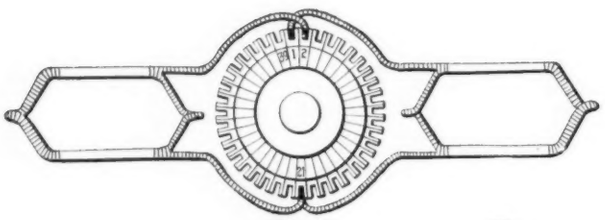


FIG. 4

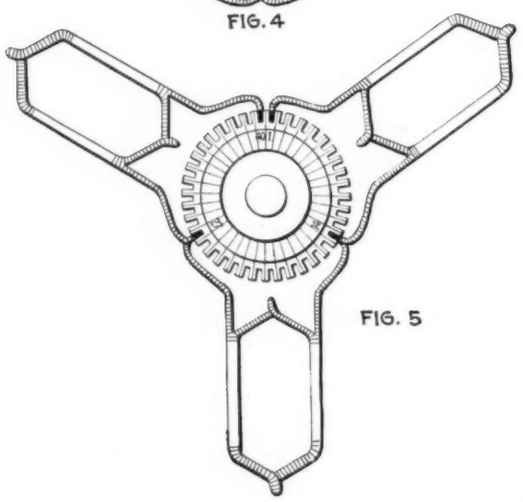


FIG. 5

FIGS. 3 TO 5. ONE SERIES OF COILS CONNECTED TO COMMUTATOR OF SERIES WINDING

per coil counted and the size wire measured. The core is then cleaned of all old insulation and given a coat of shellac or other good insulating-compound varnish.

Rewinding Four-Pole Armature

I have before me a four-pole armature that I am going to rewind, and will describe the operations as I go through them. I do not know the type of winding at the present time or the count, but from the foregoing it will readily be seen how to go about finding it.

The number of slots in the core is 15 and the number of bars in the commutator 29. Referring back to the data previously given, it will be found that this winding is four layer, that there is one side of four different coils in each slot. Two coils per slot would give 30 coils, and as we have only 29 bars, it would be impossible to connect them all, so one coil is wound in, but its leads are cut off short and it is not connected to the commutator. If this was not done, two slots would contain one side of only three coils instead of four, which would leave the armature out of balance mechanically and also allow the wires to move around in the slot and eventually destroy the insulation and cause grounds and short-circuits.

Stretching a string from the center of the slot to the center of the shaft, the top leads from one slot are found swung over to the left 6 and 7 bars. Since there is one side of four different coils in each slot, there are two bottom leads and two top leads coming from each slot. Lifting the leads about halfway round, the other ends of the coils are found brought out straight and the distance between these leads is from 1 to 15, or 14 bars between.

Checking the Winding Data

Checking this result, 29 minus 1 equals 28, divided by 2 equals 14; 1 plus 14 equals 15, 15 plus 14 equals 29, which is adjacent to bar 1 and is correct.

Before stripping the winding, measure the distance the end of the winding projects beyond the end of the core; in this case it is 0.75 in. The spread of the coil is found to be from slot 1 to 4. The winding can now be removed and the number of turns in one or two coils counted, which in the case in hand is 10 turns.

These results must be tabulated in a notebook and kept for future reference, thus: Number of armature slots, 15; number of commutator bars, 29; coils spread slots 1 and 4; top leads throw 1 to 6 and 7 to the left; bottom leads throw, straight; leads spread, 1 to 15 (14 segments between); coils have 10 turns of No. 17 double-cotton-covered wire, and the wire weighs 2 lb. This last item can be determined by weighing the coils after they have been removed from the core. Any other information can be kept along with these items, such as insulation, time to rewind, cost, etc.

Before rewinding, clean the slots in the commutator bars so there will be no difficulty in getting the wires in and file the top and side, Fig. 6. Scrape in between the commutator bars to remove all carbon dust, also on the ends. Using a 110-volt circuit and lamp test between each bar and also each bar to ground, if the insulation is in good condition there should not be the slighest spark between bars when the 110 volts is applied. If there is a defect, even though it is on the surface of the commutator, scrape it away until it tests clear. Do not allow the test to burn the carbon deposits away on the surface of the mica, as it only injures the insulation.

If the commutator tests out clear, the insulation for the armature slots can be cut to size, so as to allow it to project by the end of the core about $\frac{3}{16}$ in. on each end, and about $\frac{1}{2}$ in. above the core; this will protect the wire as it is wound into the slots. It is preferable to insulate the slots with oiled linen and fiber in the form of a sandwich. For instance, suppose that the

slot insulation used is 30 mils thick, make this up of 5 mils of oiled linen and two thicknesses of fiber each 5 mils; this will make 15 mils on each side of the slot, or a total of 30 mils.

In the armature under consideration the insulation as measured from a piece of the old material taken from a slot is found to be 10 mils in thickness, therefore it will be better to make this up of 5 mils of oiled linen and 5 mils of fiber, because if two pieces of 3-mil fiber is used it would be too thin to stand the handling

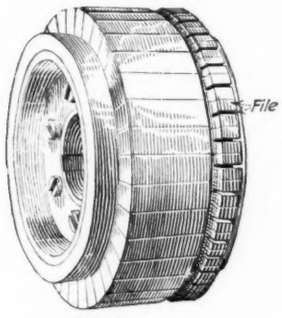


FIG. 6

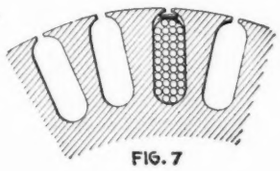


FIG. 7

FIGS. 6 AND 7. COMMUTATOR AND CROSS-SECTION OF ARMATURE SLOT AND COIL

of the wire and would break. The slots are 2 in. long by $\frac{1}{2}$ in. wide and $\frac{5}{8}$ in. deep, shaped elliptical. The insulation is cut $2\frac{3}{8}$ in. long by about 3 in. wide. In addition to this small pieces of oiled linen will be required to place between the ends of adjacent coils as they are wound, thus increasing the insulation between them.

Everything is now ready for the wire, and as the winding is four-layer, two wires can be wound together. To accomplish this, wind half the wire needed upon a second spool and then two wires can be wound into the same slot at once. Mark one of these spools No. 1 and the end of the wire coming from this spool with shellac or blue pencil; when the coil is completed, mark the other end to correspond. This will save a lot of trouble testing out when all the coils are in place. If No. 20 wire is used it would require four wires to be wound together and the wire would have to be wound upon four spools, marking two of them instead of one. It would not make any material difference which of the coils in the same slot came first, but it would make a difference if coils in two different slots were crossed. Begin at any slot, call this slot 1 and wind the first two coils in this and slot 4, then use the next slot and proceed until all are full, placing a piece of oiled linen in between the ends of the coils. Now cut the projecting insulation and turn back into the slot, pushing in a piece of $\frac{1}{16}$ fiber to cover and hold the wire in the slots, as this armature has no bands. A cross-section of one slot with the insulation and winding is shown in Fig. 7.

Looking up the throw of the bottom leads in the data taken from the armature, it will be found that they come out straight. Use the string to find the commutator bar that is opposite the slot started from, then bare the ends of the leads and place them in the commutator, leaving the top ones out. Get all the leads in rotation—that is, one marked and one unmarked lead all the way around the armature—then cover them with two layers of tape. When these leads are placed in the commutator, the ends will project out on the bars for about an inch, but do not cut them off short as it might be possible that some of these leads are twisted, and have to be changed. When the leads are being put down, interweave a piece of tape so as to properly separate each lead from its neighbor. When all the way around, one coil will be left over; this is the dummy coil already spoken of, and its ends must be found and cut off short. It is sometimes more convenient to place one or two coils in the slots and then put their bottom ends in the commutator instead of waiting until all coils are wound.

We are now ready for a test, and this must be made before the top leads are brought down to the commutator—first for rotation to see that no leads are twisted, then for shorts and opens. Arrange the top leads in the order that they come out of the slot and begin anywhere with the test lamp. Place one end of test circuit on the top lead and with other terminal find the commutator bar that the bottom end is connected to; this will light the lamp if there is no opening in the coil. Keep in contact with the top lead and touch the bar on each side of the one that the bottom lead connects to; no light shows no short-circuit between coils. Mark the bar which lights with chalk or anything else to identify it and place the test lead on the next commutator bar; a light should be obtained on the next top lead. Continue this all the way around. If any are crossed, make the correction on the bottom leads. Finally test for grounds; place one test lead on the core and with the other touch on each bar of the commutator. Next run a layer of tape over the bottom leads to make a nice even surface on which to lay the top leads, completely covering the ends of the coils, and begin to lay down the top leads. Select

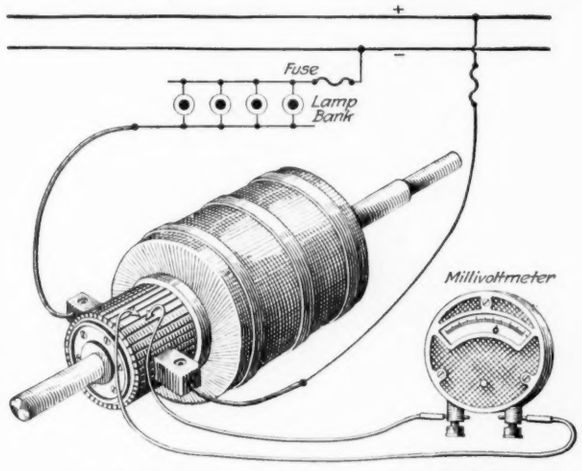


FIG. 8. METHOD OF TESTING ARMATURES

one top lead and find the other lead of this coil in the commutator, count toward the top lead 15 bar and place the top lead in this bar, and continue in rotation, making sure that none get crossed.

When all the leads are in place, hold them down with a temporary string band and place a little noncorrosive soldering paste on each bar and solder the leads in place. Raise the back end of the armature slightly to prevent the solder from running down the back of the commutator. Wash the commutator thor-

oughly with gasoline to remove all traces of soldering paste. Lastly, test with a millivoltmeter; the test can be made before or after the commutator is turned down.

With a bank of lamps in series, place two leads from the 110-volt circuit at points on the commutator where the brushes will rest when the armature is in place; that is, one-half way round for two-pole machine, one-quarter for a four-pole machine, etc. Pass a current through and measure the voltage between bars with a millivoltmeter; each reading will be the same if the work is correct (see Fig. 8).

Turn down the commutator and remove temporary string band on the leads and replace it with a permanent one. Place the armature in an oven until it is at a temperature of about 250 deg. F. for one-half hour, then remove and dip in or paint with clear insulating varnish and then rebake at a temperature of about 200 deg. F. for six or eight hours. This will make a very hard finish and warrant against the entrance of moisture or oil into the winding.

On parallel windings the procedure is somewhat simpler than that on series, as the leads of the coils are both brought together on one side of the coil because they are connected to adjacent commutator bars. All that is necessary is to use the string to find the throw of the leads, either to the right or left, and the spread of the coil in the slots. Usually, with small wires the coil is wound in, say, slots 1 and 4; then, instead of cutting a lead on the coil long enough to reach to the commutator readily, the wire is looped and the next coil immediately started. When the winding is completed, a loop is placed in each commutator bar; this will be the same as placing the ends of one coil in adjacent bars. The baking, etc., will be taken care of in exactly the same manner as for the series-connected winding described in the foregoing.

Portable "Chaingrip" Pipe Vise

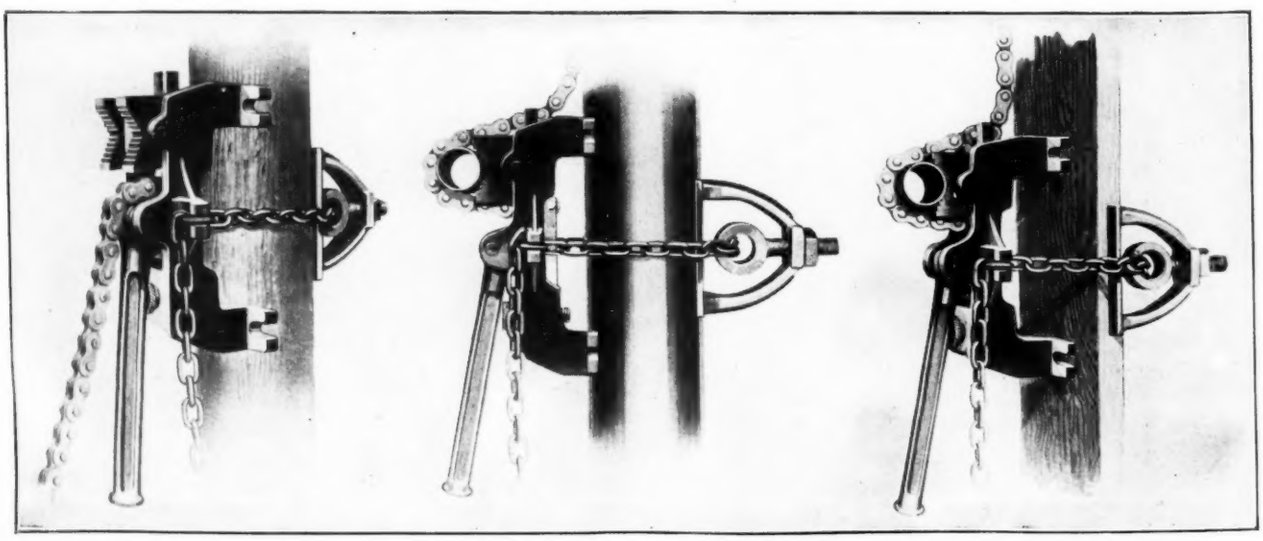
Most pipe vises are made to be permanently secured to a bench, and when the pipe has been threaded it must be carried to the point where the work is being done. Frequently, a portable vise bench is made, but it is not always convenient nor is it possible to move it to the point where it is wanted.

A portable vise known as the "Chaingrip," which can be easily and quickly removed from one location and mounted at another, is made by the Gerolo Manufacturing Co., Old Colony Building, Chicago, Ill. It can be fastened to any horizontal or vertical support, round, square or flat, without the use of bolts, and it locks any size of pipe or conduit within its limits by the slight push of a lever.

The base support of the vise is in the form of an inverted V, at the sides of which are bolt lugs to be used only in case the vise is to be permanently bolted in one position. It will therefore conform to a round, square or flat surface. A clamp support to fit on the opposite side of the column is a part of the equipment. The vise is clamped to any upright by means of a chain which passes through an eye-bolt that is part of the clamp. One end of the chain is riveted to one side of the vise base. After passing around the supporting column through the eye of the bolt, a link is held in position in a socket on the opposite side of the base. Screwing up on the eye-bolt nut tightens the supporting chain and holds the vise in position to the support, as shown.

The pipe or conduit is locked between a double set of steel pipe jaws on one side, and by a heavy close-linked steel chain on the other. The locking motion is accomplished by the downward movement of a lever. One end of the chain is riveted to one end of a horizontal bar which comes in contact with a cam on the lever end. The gripping chain passes around the pipe or conduit and is locked in a steel socket on the outer end of the base. The other end, or fulcrum point of the bar, is supported by a threaded bolt the enlarged knurled head of which rests upon a boss on the base of the vise. Rotation of the head of the bolt raises or lowers the fulcrum point of the bar and forms an adjustment of pressure exerted by the other end of the bar on the gripping chain when the handle of the vise is in a locked position.

The application of the vise to uprights is shown in the illustrations, also the method of attaching the vise and securing the pipe in place.



APPLICATION OF THE CHAINGRIP VISE TO SUPPORTS AND METHOD OF CLAMPING PIPE

Conditions in the Power Industry

By LUDWIG W. SCHMIDT

A digest of the reports of the United States consuls on the power situation in the various parts of the world and the influence of the war upon this important industry. Also, see "Power," Dec. 11, 1917.

THE demand for electrical power is still very great all over the world. The principal reason, of course, is the industrial activity caused by the war. Secondary influences are the shortage of fuels used for power generation and in some cases their present high cost. The latter consideration, for instance, is responsible for an increased employment of electrical power in cases where gasoline was in use formerly.

Consul Franklin D. Hale reports from Huddersfield, England (C.R. 256)[1], that there is a great demand for electrical vehicles of all kinds throughout England. In some cities electric power has been adopted for omnibus service, and at many places power for commercial electrics can be had at the rate of 2c. per kilowatt-hour. A similar report is made by Consul E. Haldeman Dennison in Birmingham (C.R. 265).

The increase in the cost of coal has compelled additional expenditures in the budget of many electrical enterprises in England. It is reported (C.R. 273) that the Glasgow Corporation estimates an increase of $121,662 in the fuel bill of its electrical central station. The difficulties created by the increased cost of fuel for many of the central stations in England have made the last year a very unsatisfactory one, notwithstanding the fact that the kilowatt-hour output sold increased nearly everywhere. It is, therefore, interesting to note that the desire for a better organization of power distribution in England is gaining ground. Consul J. S. Armstrong, Jr., in Bristol, quotes in support of this contention, part of the engineers' report of the Bristol Electricity Department, where it is said: "It appears likely that in the very near future the organization of the electricity-supply industry throughout the country will be rearranged on a much broader basis than hitherto, the country being for such purpose divided into districts irrespective of municipal boundaries or the present limits of company-supply areas, and the generating stations of the future, being fewer in number, will be equipped with larger and more efficient machinery than at present in use" (C.R. 274).

In view of the great development of the hydro-electric power distribution expected in Italy as a result of the war, remarks made by Vice Consul Ilo C. Funk about the power situation in Milan are of considerable interest (C.R. 301). Milan today draws its electrical power from the Alps, where it is produced by hydro-electric plants. Power is distributed by the Societa Generale Italiana Edison di Elettricita and the Azienda Elettrica Municipale. Although both these enterprises have steam-electric plants in Milan, these stations are used only in time of drought. The energy consumed in Milan and adjoining towns is given as an average of 800,000 kw.-hr. per day, the maximum power demand varying from 56,000 to 70,000 kilowatts. Almost all the power is three-phase 42-cycle alternating-current transmitted at 8700 volts, only a limited quantity being 110- and 220-volt direct current used for lighting purposes in the central section of Milan. Two important power plants are now under construction—one at Sesto S. Giovanni, Province of Milan, belonging to Ernesto Breda & Son; the other in Milan, belonging to the Acciajerie e Ferrerie Lombarde. Both will produce three-phase alternating current and transmit it at 70,000 volts. The lack of fuel so prevalent in Italy has made necessary great economy among all those central stations using coal for generation. It is reported from Turin (C.R. 282) that the use of electricity has been restricted, in that city, by a decree of the prefect, resulting in a reduction of consumption of 50 per cent.

In Oporto, Portugal, a company has been organized to develop the water power of the northern part of the country (C.R. 271).

Denmark is feeling the effects of the war along with the rest of the neutral countries of Europe. The principal problem at present is the need of energy for lighting and power purposes. Denmark in this respect is rather unfavorably placed, as it has few hydro-electric possibilities. On the other hand, the proximity of Sweden, with its great hydraulic-power resources, has led to experiments to transmit power from that country to Denmark over submarine cables. This, in the case of several smaller villages in the north of Denmark, seems to have met with good results. The difficulty at the present time is, the power production of Sweden is considerably reduced during the winter months, and there has not been a sufficient surplus to continue a supply to Denmark during this period. With the increase of the Swedish power-producing facilities a better employment of part of the Swedish power reserves in Denmark should become possible. Commercial Attaché Erwin W. Thompson in Copenhagen reports (C.R.296) that additional cables will be laid across The Sound with the intention of furnishing power to the street-car service of Copenhagen and Frederiksberg. This power will come principally from the Laga Lakes and the Trolhättan Falls.

From the Gold Coast in Africa it is reported that the City of Secondee will be furnished with electric light by the Gold Coast Railway (C.R. 304).

Electrical development in New Zealand and Australia continues to be very active. Consul General Alfred A. Winslow writes that the City of Dannevirke intends to build an electric-lighting plant for its 6000 inhabitants (C.R. 264). Increasing attention is given to the use of electricity in the farming and dairying districts of the South Island of New Zealand. This is the country around Christchurch, and it is intended to erect a government hydro-electric station in that neighborhood.

Considerable activity in electrical development also is reported from all parts of the American continent south of the United States. Consul G. C. Woodward, Matamoros, Tamaulipas, Mexico, says (C.R. 262) that the

[1]C. R. indicates "Commerce Reports" of 1917

FIG. 1. WALL TORN OUT BY EXPLODED FLYWHEEL

only electric-lighting plants established in his district are at Victoria and Matamoros. The supply of electric light and power for public and private use is contemplated in Santo Domingo, Dominican Republic (C.R. 262). It is also reported from that republic that a franchise to build an electric railway in the City of Santiago de los Caballeros has been annulled. This would have been the first electric tramway in the Dominican Republic (C.R. 286).

Plans are under consideration in Guadeloupe, French West Indies, to build an electric railroad with a total length of track of 118 miles. The power will be obtained by harnessing two waterfalls, which are expected to supply sufficient energy (C.R. 275).

Consul Frank Anderson Henry reports from Venezuela (C.R. 275) that the South American Copper Co. at Aroa is engaged in enlarging its present small hydro-electric plant to about 800 hp. The City of San Felipe will have an electric-lighting plant, and it is further contemplated to furnish Barquisimeto and Yaritagua with electricity generated by a large waterfall near the latter city. Barquisimeto has already a small plant using anthracite for fuel. This, however, supplies light only at night. The war has brought a considerable weakening of German influence in electrical enterprises in South America. It is reported that the Compania de Tramways Electricos del Sud, of Buenos Aires, Argentina, has not renewed its power contract with the Compania Alemana Transatlantica de Electricidad, which is a German company, but has made arrangements for a power supply from the new Compania Italo Argentina. The income of the tramway company shows a falling off, and the operating expenses have increased (C.R. 234).

Interesting information as to power development in Peru is contained in a special report by Consul General William W. Handley, Callao, Lima (Supplement C.R. 46a). This report shows that the service provided by the Lima Light, Power and Tramways Co. has increased considerably with good effects on the income of that enterprise. This increase is due especially to the growing of general industrial activity in and around Lima, which holds good promise of a further extension of power demand in that city and its neighborhood.

Flywheel Explosion at Minot, N. D.

The photographs reproduced show some of the havoc caused by the failure of a flywheel on a direct-connected reciprocating-engine generating unit at the plant of the Northern States Electric Light and Power Co., Minot, N. D., at about 3 a.m., Oct. 17, 1917.

The night engineer was instantly killed and a large amount of property damaged. Fragments of the wheel went through the window and the brick wall below it, as shown in Figs. 1 and 2, rocketed a full city block (about 500 ft.), striking a newly erected brick building which was unoccupied except one apartment on the top floor, into which a piece of the wheel was driven, causing the damage shown in Fig. 4. Fortunately, a larger engine, set at right angles with its shaft almost in line with the flywheel that failed, was not running or greater damage no doubt would have resulted, as several large pieces of wreckage were found in its wheelpit, and some wreckage may be seen near it in Fig. 3.

A curious feature was the damage to a box-car and the tearing out of two rails from the main track of the Great Northern Ry. The "Oriental Limited" was about due, but was flagged in time to avoid a wreck. The city was without light until the débris was cleared away and numerous repairs made to the damaged plant.

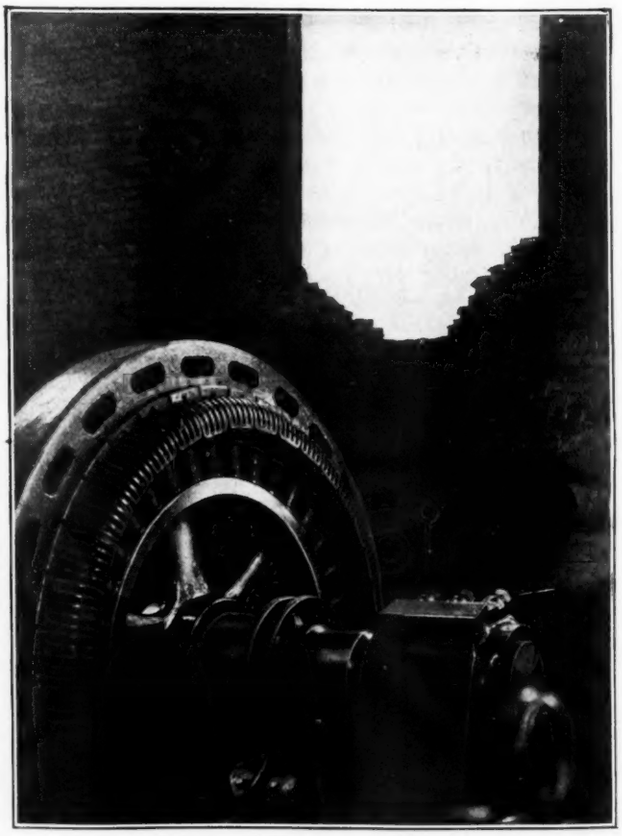


FIG. 2. VIEW FROM INTERIOR OF ENGINE ROOM

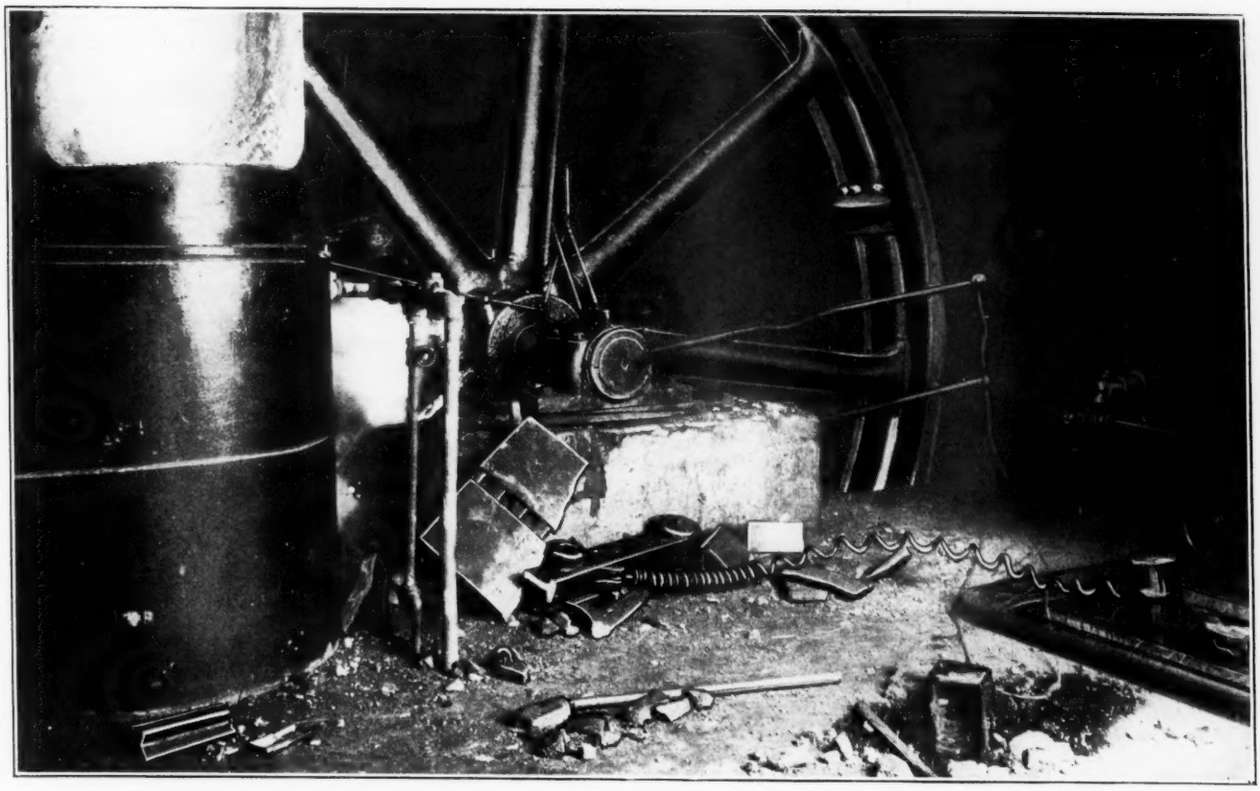


FIG. 3. FRAGMENTS OF FLYWHEEL AND GOVERNOR AGAINST FOUNDATION OF IDLE ENGINE

FIG. 4. INTERIOR OF APARTMENT WHERE DAMAGE WAS DONE

Average and Maximum Heating Demand

By M. W. Ehrlich

In heating work it has become an established custom to design plants to provide a temperature of about 70 deg. indoors when the minimum outside temperature is zero, but during the season the outside temperature may be as high as 65 deg., when but little artificial heat is needed. This range of outdoor temperature corresponds to conditions in the Middle Atlantic states; elsewhere the minimum outside temperature may be considerably above or below zero, therefore the local weather bureau records should be consulted to learn the lowest temperature. However, it is customary to base calculations for average conditions for the range from zero to 70 deg. In many localities zero weather may

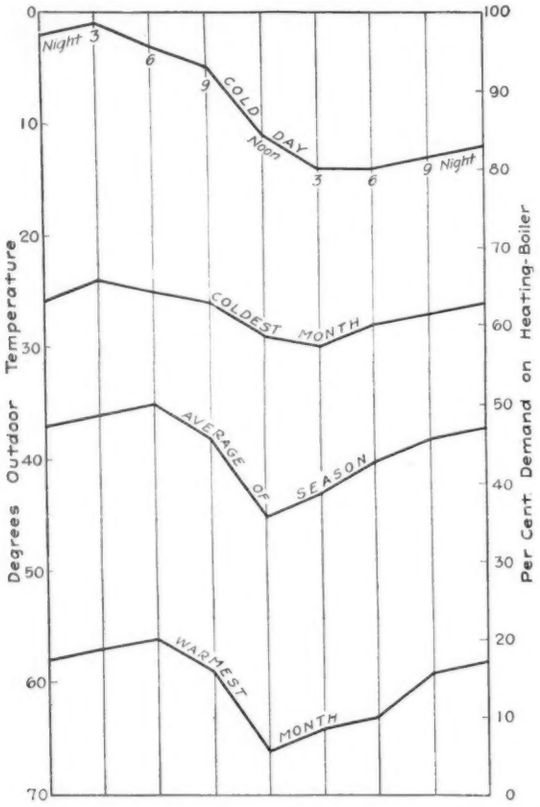


FIG. 1. TYPICAL TEMPERATURE-FLUCTUATION CHART

not be reached except in January and February, and then only during the early hours of the morning, just after midnight, lasting for periods of not more than about three to four hours at a time during the entire season.

The maximum demand for heat therefore obtains only for very short periods. The average requirements for the locality referred to are given graphically in Fig. 1, which shows the typical fluctuations in outdoor temperature during a day in the coldest and the warmest month and for the entire heating season. The scale at the left gives the temperature in degrees, and the scale at the right is assumed to be the corresponding tax on the boiler plant to supply the required steam. The curve of the "warmest month" might represent April, while the "coldest month" might be January or February. In the first case the boiler would be taxed an average of about 15 per cent. of its capacity, while in the other case the average monthly demand is about 62 per cent., and for an "extremely cold day," the minimum temperature is nearly zero during the night, gradually rising to about 14 deg., averaging about 9 deg., taxing the boiler during that day to about 87 per cent. of its capacity. The average temperature for the heating season in New York City is about 38 deg., requiring approximately 44 per cent. of the assumed maximum boiler capacity.

The amount of coal or steam, which is the tax on the boiler, therefore is a proportionate variable of the outdoor-temperature fluctuations, and on this basis, using zero temperature as a maximum demand, diagram Fig. 2 has been prepared for average conditions in New York and vicinity or other localities having similar climatic variations during the heating season. It is intended more as an illustration of how such diagrams are constructed and used than as a standard of computation. As an example it should serve its purpose well.

The load curve, shown shaded, may represent the amount of coal or steam or boiler tax for each month. The scale at the left is given in percentage for convenience, as in that way a relative value is at once established regardless of the unit and numerical value selected. The monthly coal requirements are expressed in percentages of the total used during the season. For example, during December 18.2 per cent. of the coal used during the entire heating season will be consumed, while in April only 9.8 per cent., showing that considerable coal is wasted because the boiler drafts and radiators are not controlled in conformity to the weather variations, but with automatic temperature regulation and draft control the steam demand would correspond closely.

Keeping a Record of Outside Temperature

A monthly check on the coal consumption is conducive to operating economy. For a given locality it is therefore necessary to construct a diagram similar to Fig. 2, which would take the local weather conditions into consideration. By keeping a record of the outside temperature, either through personal observation or by watching the newspapers if there is no local weather bureau, the essential information may be obtained. It is useful to record at least the average daily temperature on the power-plant log sheet. Some engineers note down in addition the maximum and minimum outdoor temperatures. Then, according to the records, taking 70-deg. temperature difference as a basis, the average temperature for November is, say, 43 deg.; then 70 less 43 gives 27 deg. difference, and dividing this by 70 equals 38.6 per cent. Likewise in January the average is, say, 25 deg. and the difference is then $70 - 25 = 45$, which divided by 70 gives 64 per cent. In the same way the relative heating demand for each month is determined and plotted. It should be noted that the divisor is the maximum or basic temperature difference, which represents 100 per cent. From the values found as shown, the average of the season is computed as well as the relative monthly coal requirements.

The actual quantity of coal required for a heating system is dependent on the variables heretofore noted, and for a particular installation the local physical condi-

tions must also be known. This would mean the total or equivalent square feet of direct radiation in the building, the number of hours the system operates during the heating season and the grade of coal burned. The computation for the tons of coal required for the heating system during the season is:

$$\text{Tons of coal} = \frac{\text{sq.ft. radn.} \times \text{hours operation} \times 300}{\text{heat in coal} \times 2000 \times \text{efficiency}} \times \text{average demand}$$

This computation may be simplified for practical application as follows, so that the result will be the tons of coal approximating fair operating conditions. The

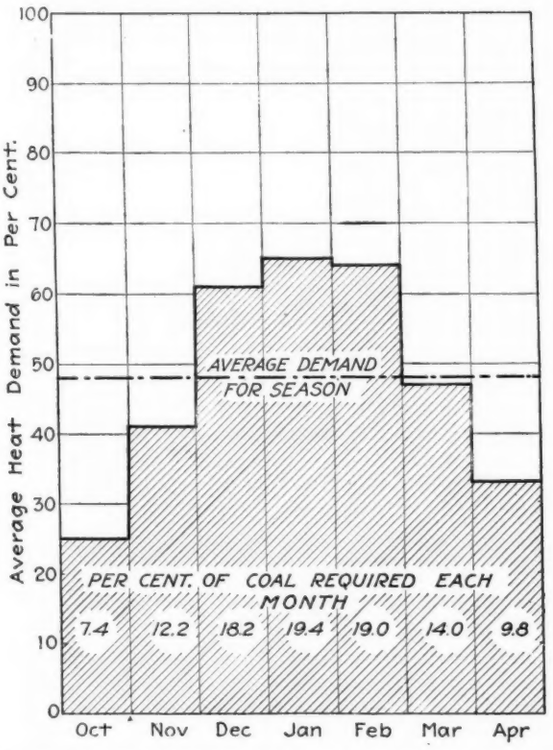


FIG. 2. SEASON'S MONTHLY AVERAGE TEMPERATURE

variables are well accounted for in the fact that there are losses when fires are banked and cleaned and that the draft control does not correspond exactly with the weather variations. These variables comprise the useful heat in the coal, the over-all efficiency and the average heating demand.

The average demand on the system for the entire heating season is a value that must be determined for the particular locality in which the plant is situated, as it depends on the weather variations and may be arrived at in the manner explained in connection with Fig. 2.

Taking all these variables as one combined whole, the component may be designated as a factor to be used in the simplified formula. This factor would naturally vary for different localities because the weather conditions give a different average demand on the system. It would also vary for hard- and soft-coal operation because of the characteristics of these fuels. Then, for observed averages of operation and heating demand in steam plants using hard and soft coal, the values for this factor may be computed for different localities. The numerical values of this complex factor so computed have been designated as f and are given in the tabulation herewith.

TABLE GIVING VALUES OF FACTOR (f)

Location	Hard Coal	Soft Coal
Boston, Mass	85	80
Columbus, Ohio	84	78
Detroit, Mich	89	83
New York, N. Y	7o	73
Philadelphia, Penn	75	70
St. Louis, Mo	64	60

These values, when used in connection with the following formula, give a close approximation of what the coal consumption should be under fair operating conditions. The factor f may therefore be said to represent the tons of coal used per hour during the heating season for each square foot of radiation for a given locality when applied specifically to the formula which gives the total tons of coal required for the heating season as equal to:

$$\frac{\text{Sq.ft. radiation} \times \text{hours} \times f}{10{,}000{,}000}$$

Consider for example a shop running 24 hours a day for 200 days in the vicinity of Boston and the installation consists of several indirect radiators, pipe coils, and many regular cast-iron radiators, aggregating an equivalent of 2380 sq. ft. direct radiation. What will be the coal consumption under this condition? According to the foregoing the computation is as follows: 24 hours times 200 days gives 4800 hours as the total operating time. The average demand corresponding to f is 85 for Boston, when anthracite coal is used. Then, tons of

$$\text{coal} = \frac{2380 \times 4800 \times 85}{10{,}000{,}000} = 97.1 \text{ tons.}$$

Then with 97 tons required for the heating season, the monthly use of coal can be determined as has been shown, but it is a variable corresponding to the weather and not a direct fractional proportion of the total months in the season. Assume that this condition corresponds to the load diagram, Fig. 2. It will be seen, for example, that for the month of December 18.2 per cent. of this total, or about 17.7 tons of coal, will be required. In the same way it is found that during the month of March 14 per cent. is consumed, which is equal to about 13.6 tons.

Determining the probable coal consumption by the method outlined, gives a means of comparison, for if the actual coal consumption for any month exceeds the quantity as computed for the weather conditions and temperature differences, then apparently some coal has been wasted. If the difference is quite small, it may be just a variation due to averaging, but if there is a wide discrepancy, the conditions justify an investigation so that the same leak or waste will not occur or appear again.

This method of computing the coal consumption will be found to agree closely with practical conditions, and as a means of checking the operating efficiency of the plant it will be found helpful. Engineers who keep plant records or log sheets usually know what the total coal consumption is for the entire plant and equipment. Deducting the coal required for the heating system gives a remaining quantity that shows the other useful service the coal has given. If this figure is too high for the load carried, something requires attention and the sooner this waste is found and things set right the sooner will the over-all efficiency begin to pick up.

A Traveling Anti-Waste Exhibit

In a large manufacturing plant where thousands are employed, it is surprising to learn of the food products and manufacturing material wasted each day.

To give the employees of the Westinghouse Electric and Manufacturing Co. some idea of the waste, the management devised the idea of fitting up a storage-battery truck as a traveling exhibit and upon it a collection of food wasted, including bread, butter, meat, cakes, crackers, pickles, cheese, fruits, etc., as well as a quantity of manufacturing materials such as copper, zinc, lead, mica, rubber, felt, gum and similar materials, much of which could be used to advantage.

It is estimated that the foodstuffs wasted every day amount to between $35 and $50, the cost of which, of course, comes out of the employees' pockets; the waste of material amounts to hundreds of dollars per day—which would be a loss to the company if it were not that

A TIMELY OBJECT LESSON

a force of men are continually assorting the seemingly scrap material and turning it back for use or so that the highest price may be obtained for scrap produce—all due largely to the carelessness of the employees.

Above the material is a sign reading in large letters, "Wasted"; and underneath the words, "Food Brought from Your Homes"; and on the other side, "Material Belonging to the Company."

This truck was driven up and down the shop aisles so that the employees could look upon it and form in their minds some idea of the waste. Such an object lesson is valuable at this time, when everyone should reduce waste as much as possible.

Fuel Saving "Don'ts"

To assist the Fuel Controller for Canada in his campaign for fuel conservation, the General Accident Assurance Co. of Canada has prepared the following series of "don'ts," which have been printed and are being distributed to manufacturers and boiler owners:

1. Don't fill the furnace with the intention that there will be no necessity for any additional fuel for the next two to four hours. This is quite a common practice with heating boilers, and with bituminous fuel results in very great waste.

2. Don't regulate the draft by closing the ashpit door, but regulate it with a damper in the smoke flue or pipe between the boiler and the chimney. This also applies to any kind of furnace.

3. Don't allow any cracks in the brick setting of the boiler, because cold air will enter through these cracks and absorb the heat that should have been transferred to the boiler.

4. Don't permit the use of grates of any kind which are in bad condition. This will permit the unconsumed fuel to fall through to the ashpit and be shoveled out as ashes or waste.

5. Don't use a grate that is larger than will permit the burning of at least 12 lb. of coal per square foot of grate per hour.

6. Don't permit any pipes or boiler surfaces to remain uncovered, unless it is necessary to transmit the heat through the surface of that pipe to the room in which it is located.

7. Don't permit any joint in the boiler or any pipe connected thereto to leak.

8. Don't permit any valve to leak which is located on a pipe supplied by the boiler. This is a very common source of loss. All valves should be positively tight when closed.

9. Don't attempt to control the quantity of condensation to be collected from any pipe or other apparatus by hand control. There are many good serviceable traps to collect these returns of condensation and they should be returned from these traps to the boiler.

10. Don't permit any surface on the boiler exposed to the furnace heat to become covered with soot or ashes. The tubes should be cleaned at least daily.

11. Don't use live steam for heating rooms, liquids or other substance when there is exhaust steam from engines or pumps available. If the exhaust steam is not of sufficient temperature to heat the room, the liquids, or other substance to the required temperature, arrange your heating to be done in two stages; for instance, water could be heated to nearly 212 deg. F. by exhaust steam, then passed through to another vessel to be heated to the desired temperature with live steam.

12. Don't feed a boiler with cold water when there is exhaust steam available to heat it. Every eleven degrees in temperature that feed water is raised by heating by exhaust steam there is a saving of 1 per cent. in fuel, and in wintertime especially feed water is very seldom any warmer than 42 deg. F. If this water is heated to 212 deg. F. it will then effect a saving of 15 to 16 per cent.

13. Don't allow the main steam valves on any engine or pump to leak. This is a very common fault, due to the fact that the leak is not seen.

14. Don't allow the piston of any engine or pump to leak. This is also a common defect permitted to go on day after day simply because the leak is not seen.

15. Don't take it for granted that pipes that lead to sewers, blowoff tanks or other places of discharge are tight. If the pipe is warm between the stop valve and the source of discharge, it will generally pay to investigate a little closer, because it generally is a sure sign of leakage, with great waste.

Editorials

Use Surplus Productive Power To Rehabilitate the Railways

THERE are indications on all sides that we are approaching an industrial and economic crisis. One of the most evident signs of this is the amount of criticism which is being showered on those in charge of Government activities, nearly all of which at present relate to the war. The attempts to blame these various inefficiencies on individuals are being made on all sides. It was only natural in this confusion that Army officers and Government officials in general should be the first to receive the blow, for we have always held the theory that Government officials were far more inefficient than our business men.

The number of applications from private manufacturers for the help of "efficiency engineers," which has so largely increased lately, is indicative of a realization on the part of many of our manufacturers that their methods also are not what they should be. The people who are applying for help are in many cases no worse off, as far as their methods are concerned, than others who have not yet discovered how badly they are doing their work. The whole subject seems to resolve itself into the fact that our business and industrial systems are not suited for times like these, when it is necessary to combine all our energies and exert our full driving power toward the achievement of one supreme object.

We should not be surprised that this is the case, for our economic theory has never contemplated teaming up all the industries of this country for one object, but has rather discouraged that idea and encouraged individual competition of the most strenuous kind. In other words, we are a nation of individualists who have never really seriously contemplated coöperation for the common good.

When this problem of coöperation is suddenly put up to us as it has been by the war, it is not surprising that our business men, trained in the individualistic school, should be entirely unfitted to solve the new problem. Moreover, it might be expected that the men who have been most successful in individualistic, competitive business, in which profit was the main aim, should be actually the ones least fitted to establish a scheme of business and production for the benefit of the community. This is a new problem to them, and one altogether outside of their experience.

It is to be granted that such business men may have individually great driving power, but this very excess of driving power in individuals or corporations is likely to make the confusion all the worse, unless a means of coördination is established which will keep the driving power of the individuals or corporations in proper balance.

It has become perfectly evident to all observers that the capacity of the nation for production of war material is enormously greater than its capacity for shipping it to Europe, and that we must at once not only balance this production, but slow it down in order to prevent such a choking of our Eastern ports as may produce an impossible condition. The five-day shutdown ordered by the Fuel Administrator and the one day per week shutdown are our first attempts to slow up this production, and we ask ourselves at once if this is the best way. The answer comes that if we are making too much war material we had better turn such of our activities as cannot be utilized in increasing our shipping capacity into the manufacture of articles of peace. Immediately we run into the financial situation, which at present seems to seriously hamper new undertakings.

It would seem that the claim of the railroads that they need $1,000,000,000 worth of improvements should at this juncture be considered. Here is one organization now devoted exclusively to the service of the community, which, being under the control of the Federal Government, can be financed directly by that Government, and there would seem no reason why the production programs of war material should not be limited, and a certain amount of the energy now being expended in that direction turned at once toward the improvement of our transportation facilities.

Our Fuel-Oil Supply

NATURE has been prolific in her provision of fuels for the benefit of man. The potential energy locked up in the interior of this planet of ours is enormous. The world's coal reserve, according to a recent estimate, is roughly 7,397,553,000,000 tons. Miners are cutting into the supply at the rate of about 1,500,000,000 tons per year, or less than two-hundredths of one per cent. In all probability the estimated amount of the world's coal reserve is much below the actual figures given, since coal is occasionally found in territory yet unexplored and in localities where its existence was not previously suspected.

The present world conflict has accentuated the demand for liquid fuel to the extent that the magnitude of our petroleum supply is one of the questions of the hour. The present demand for petroleum is in excess of production, in spite of the fact that over three hundred million barrels was marketed in the United States alone in 1916, and the estimates for 1917 and 1918 are 319,000,000 and 338,000,000 barrels respectively. Since the United States in normal times produces approximately sixty-five per cent. of the world's petroleum, we may expect a petroleum consumption for 1918 of over half a billion barrels. With the consumption increasing at the rate of six per cent. each year, we have a right to be somewhat concerned about the source of our future supply.

Where is the oil to come from? Unlike our coal resources, we have no means of estimating the contents of the oil sands below the earth's surface. Whether our oil

reserve is being rapidly depleted or not, we have no means of telling. We may be fast approaching the limit, or we may be just scratching the corners off, as in the case of coal. This refers to our supply of oil from wells.

The history of the petroleum industry would tend to make our forecast optimistic in a way, while the general tendency is toward the pessimistic view. This attitude is caused more by the habit of jumping at conclusions than basing our decisions upon actual facts. We have it as the opinion of one well informed in the oil industry that there are possiblities of new fields in every state in the Union. It is a matter of fact that oil is often discovered in most unexpected places. Localities that are considered today as of no importance in the oil industry may, a few years hence, be pouring out a flood of oil.

This statement is substantiated by numerous examples. The production of the Kentucky oil fields was in the front rank for November, 1917, yet about a year ago this state stood at the bottom of the list. Wyoming is fast becoming an important factor in production. While six years ago its output was of practically no account, today it is giving us about five million barrels a year. But the rise of Oklahoma as a producing state was, perhaps, the most spectacular. In 1906 its production was so small that it was included with that of Kansas; in 1915 Oklahoma passed California and stood in the front rank with a production of nearly ninety-eight million barrels, which was 34.83 per cent. of our total production. This would give a reasonable foundation to hope for the discovery of new fields from time to time as the demand increases the incentive to search for them.

Leaving our own shores, we find that there is much potential oil territory in many parts of the world. China, for example, promises much for the future, although the present production in that country is small. Oil territories are being exploited in Australia and New Zealand. Many parts of South America hold out promises; for example, the oil fields of Argentina and Peru are already of considerable importance.

Passing from the oil well as a source of supply, we have within our borders another source of this valuable fuel, of almost limitless extent, as yet untouched. Unlike the oil from wells, it is possible to estimate the extent of this supply. Covering 100,000 acres in northwestern Colorado and extending into the neighboring states of Utah and Wyoming, there is practically a whole mountain range of bituminous shale, rich in oil. The sides of the precipitous cliffs in this region show layer upon layer of rich oil shale. A careful survey of this region, by representatives of the United States Geological Survey, indicates a deposit of petroleum in Colorado alone, of at least twenty billion barrels. Comparing this deposit to the output from oil wells, it is found to be nearly three times the total production of petroleum in the world from the beginning of the industry in 1857.

Analyses of the oil distilled from this shale show it to have a paraffin base and to be of most excellent quality. Chemical engineers state that it shows a gasoline content as high as 25 per cent. It carries valuable byproducts, chief of which is ammonium sulphate. The value of this one byproduct is sufficient to pay almost half of the cost of extracting and refining. So valuable are these deposits considered by our Government that the President on December 6, 1916, set aside forty-five thousand acres, or nearly one-half the Colorado shale-oil field, as a fuel reserve for the United States Navy.

There is nothing difficult about extracting oil from shale. The shale-oil industry has been a profitable enterprise in Scotland since the early fifties, and the output of oil from Scotch shales today is approximately two million barrels per annum.

But we need not stop here in our estimate of the liquid-fuel reserve. More or less oil shale has been discovered in many other states. In many parts of Ohio and Indiana, oil-well drillers penetrate a strata of dark brown shale, about one hundred feet above the Trenton sand. From the best information obtainable, this is a deposit of oil shale which it may pay us to mine some day, as is done in Scotland. We recall having seen the statement by one of our Government geologists that, in the oil shales underlying Ohio and Indiana, there is sufficient oil to fill Lake Huron. It would appear from this brief statement that we have no cause for alarm as to our oil supply for the immediate future, whatever the situation may be a generation hence.

Not Developing the Water Powers

IN view of the fact that some 60,000,000 horsepower is continuously going to waste in the streams of the country, it is beyond comprehension why an enlightened people like ours should not only fail to encourage, but should blindly bar the way to the development of a great natural resource so important to the well-being of the nation. When we consider the benefits which have already accrued to industry from the water powers now developed and recall how we have besought, appealed and pleaded for legislation to permit further development, we contemplate the present unhappy power situation with pain and sorrow. How the cry for power must strike with hollow mockery the ears of the water-power obstructionist!—*Exchange.*

THE data show that 120 out of about 1500 public-service corporations claim to own or control a total of 3,683,000 undeveloped water horsepower, or 80 per cent. of the total water power at present developed by public-service corporations.

Those who lay claim to such extensive ownership or control of undeveloped power sites are hardly in a position to contend that any legislation or lack of legislation or any administrative policies of the executive departments of the Government should be held responsible for the stagnation in water-power development which they allege exists. The fact, if it is a fact, that a comparatively few corporations hold unused nearly 4,000,000 water horsepower would of itself furnish sufficient explanation.—*O. C. Merrill, Chief Engineer, Department of Agriculture.*

Garabed Giragossian has appointed a commission satisfactory to Secretary Lane, to pass upon the merits of his alleged invention whereby unlimited power is to be gathered from a new source. In case he demonstrates to the satisfaction of the commission that he has anything, the Government has the free use of it, but guarantees him in the control of all other uses of it for seventeen years. In case he doesn't satisfy the commission—Oh, well!

All that one does in his lifetime that really counts is done in a short number of hours. The rest of the time is consumed in getting ready and in waiting.

Correspondence

The Administration's Water-Power Bill

The twelve-year fight to keep the nation's water power from capture by the power monopolists is at last on the verge of being won. The Administration water-power bill now before Congress opens the way to save for the people of the United States their most valuable natural asset. Some fifty million water horsepower is at stake. The bill in question was formulated under the direction of the Secretary of Agriculture, the Secretary of War and the Secretary of the Interior, was submitted to the President for his approval and recently put forward as an Administration measure. It deals with water power in national forests, public lands, Indian lands and navigable streams. A special committee of the House has been created to consider it.

It is an admirable measure, drawn with thorough knowledge and unusual skill. The principles essential for the wise use and development of our public water powers in the public interest are all embodied in it.

I have always urged the support of the following seven definite principles in water-power legislation:

1. The thing to do with water power is to develop it. Whatever retards or restricts the development of public water powers on terms fair to the public is against public policy and hostile to the general welfare.

2. Water power belongs to the people. The sites where it is produced should always be held in public hands, for only so can effective control in the general interest be secured.

3. Where public development is not desired, the right to use water-power sites should be leased for periods long enough to permit sound, attractive and profitable investment, but never longer than fifty years. At the end of each lease all rights should return to the people who gave them.

4. In order to protect the consumer against extortion, rates and service should be regulated by Federal authority when state or local authorities fail to do so.

5. Reasonably prompt and complete development and continuous operation, subject to market conditions, should be required. Already millions of water horsepower are held out of use to further monopoly by private corporations.

6. Corporations or individuals that make money out of rights granted by the people should share their profits with the people.

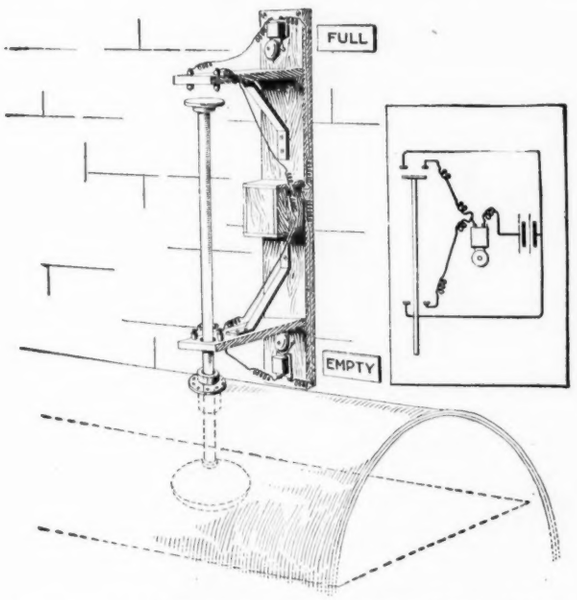
7. The public has a right to complete information about every business based on the use of public property.

It is a real pleasure to know that every one of these principles is fully safeguarded in this bill. What remains, therefore, is for Congress to put this measure through without delay. The Administration water-power bill will first come before the House of Representatives, where an effort will certainly be made to amend it in the interest of the power interests. If that fails, the water-power lobbyists will endeavor to have the indefensible provisions of the Shields bill substituted in the Senate for the Administration bill. Beaten in that, they will fall back upon the formula of obstruction and delay they have used so successfully for the last ten years. This measure is practical, fair and wise. The friends of conservation should insist that their friends in Congress shall give their prompt and full support to the Administration bill and shall see to it that it is passed without emasculation, substitution or postponement. It is of vital interest to our country while the war is on, and will be equally important after the war is over. The passage of this law will secure to the American people forever vast resources whose use for the good of all will make this land a safer and a better place to live in. All the forces of conservation are behind it. I urge you to give the bill your strongest approval and support.

Milford, Penn. GIFFORD PINCHOT.

High- and Low-Water Alarm

The illustration shows without the need of much explanation a device for ringing an alarm bell when the water in a tank is high or low. As the water and the float lower, the cross-piece or disk on the end of the rod



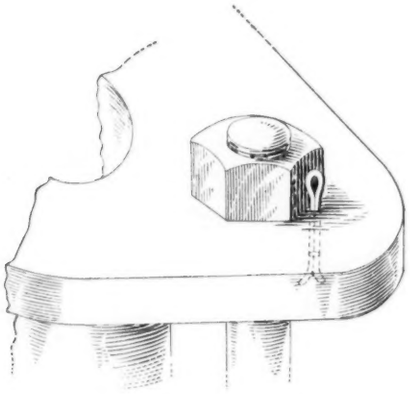
FLOAT-OPERATED HIGH- AND LOW-WATER ALARM

completes the electric circuit at the contacts, which causes the alarm bell to ring. When the water rises to a predetermined point, contact will be made at the other terminals and the high-water bell will ring, giving notice that it is time to stop the pump. Two bells are shown, but both of the contacts can be connected with the same bell if desired. D. R. HIBBS.

New York City.

Securing Gland Nuts

The valve-stem stuffing-box gland nuts on Corliss engines often give trouble by working loose and allowing the packing to blow out, requiring a shutdown to repack. This is more often the case on old engines that have worn valve stems having a side movement, every time the hook picks up the steam arm, which tends to move the gland and work the nuts loose. There is



COTTER PIN TO KEEP NUT FROM TURNING

sometimes scant room on the studs for the jam nuts, so the engineer has to keep a close watch on the single nuts to keep them tightened. While overhauling recently, I drilled a small hole in each end of every gland in such a position that a small cotter pin inserted in the holes acted as a nut lock. This is also a good kink to use on the piston-rod glands of big engines and may prevent a serious accident. J. W. STANLEY.

Braemar, Tenn.

Power-Plant Burns Locomotive Sparks

My attention has been called to an article in *Power*, page 13 of the Jan. 1 issue, descriptive of a large electric power station in Germany wherein locomotive cinders are burned under the boilers. It is said to be "the first large railway power station in the world to be operated entirely on cinders taken from the locomotive."

It may be of interest to recall that twenty years ago the New York, New Haven & Hartford R.R. built three power stations, from 500 to 2500-hp. capacity, in which horizontal return-tubular boilers were fitted to burn this same kind of fuel. Most of this work, both construction and operation, was under the immediate supervision of the writer who, at that time, contributed an article to *Locomotive Engineering* in which it was described fully.

To most railroad men locomotive cinders are known as "sparks" and are, of course, small pieces of partly burned coal, which is really coke, drawn through the tubes by the exhaust and confined in the front end by the screen, from which they are dumped at the end of each trip. A number of experimenters had previously discovered that sparks could not be successfully burned by the use of the ordinary forced draft under the boilers unless mixed with coal. Success was obtained by the use of a forced draft in which steam is mingled with the air blown into the ashpit. A steam blower fitted to the ashpit doors supplied this combination. The hydrogen of the steam combined with the carbon of the sparks, forming what is commonly known as water gas. The boilers were set high above the grates, forming a large combustion chamber; they were hand-fired and not overloaded.

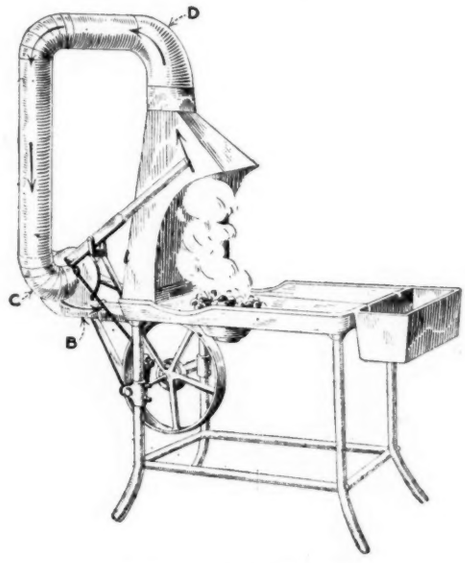
No coal was ever mixed with the fuel except on rare occasions when a heavy load dropped the steam pressure seriously. For eight or ten years, at least, to my knowledge two of these power stations were operated entirely by sparks.

Shortly after they were in operation, a number of European engineers and railroad officers (some Germans among them) were on a tour of this country and were being shown the boiler room of one station. Mr. Aspinwall, then general manager of the Lancashire & Yorkshire R.R., was closely examining the sparks and also the ashes. Holding a small portion of each in his hands he remarked: "Do I understand that you have already burned this stuff in your locomotives, and you are burning it over again here?" I replied, "That is so." "Then," said he, "pray tell me who burns it after you get through with it?" EDWARD C. BOYNTON.

New York City.

A Smokeless Portable Forge

A small forge is a handy device about a steam plant, but it has one disadvantage—it will fill the room with smoke unless there is a smoke connection to the outside, which is not commonly the case. Much of the smoke can be avoided by arranging the forge as shown



A SMOKELESS FORGE

in the illustration. I used a common forge with the hood attached, and connected at the top, at *D*, a tin pipe of the same size as the opening into the intake side of the blower *B*, as shown at *C*. When the blower is in use, the smoke that rises from the fire is drawn up into the hood in the direction of the arrows and down to the blower, which forces it up through the fire without its escaping into the open. J. A. LUCAS.

New York City.

Piston Packing Burns Out

In reply to Mr. Noble's letter on page 129 in the issue of Jan. 22, I would suggest that he look over the oiling system and make sure that the proper amount of oil is reaching the cylinder at all times. If, as he states, the material and workmanship are of the best, I am inclined to think the heating of the rod is from undue friction caused by the stoppage of the oil supply—perhaps for a short time, but long enough to permit overheating. J. H. KENDEL.

Chicago, Ill.

I believe it may be caused by any one of several reasons. The rod may be too small and at times of peak load may spring, thereby throwing excessive pressure on the packing. This might occur and yet not show in the packing for some time afterward, but the most probable cause in my opinion is in the packing itself, although Mr. Noble assures us he is using a good grade of packing and backs it up by the statement that it cost $1.50 per pound, but that is no proof that it is adapted to his special need.

Twenty-five years of engineering experience has taught me that packing can cause any amount of trouble and worry, yet I do not think that we can recommend any one brand or make that will suit all places or conditions. In former years I made many changes and tried every new packing that I could get hold of, but now I use but one make and have no packing trouble.

Syracuse, N. Y. M. E. WEBBER.

I almost "sweat blood" over an experience similar to that described by Mr. Noble, shortly after taking charge of a Corliss engine plant. The coal consumption was enormous for the size of the plant, and after setting valves and testing for leaks, I opened the boiler and found it badly limed. After cleaning by mechanical means as much as possible, I started a heavy treatment of soda ash and hydrated lime. Then trouble with piston packing began with evidences of lack of proper cylinder lubrication. We fixed up an oiler for the piston rod and did considerable fussing with the lubricator, but to no avail. It finally occurred to me that the trouble was greatest when the engine was heavily loaded; then came the inspiration, the boiler was foaming! That was easily remedied, and we had no more trouble on that score.

The next day we cleaned the boiler and, before refilling, put in a gallon of kerosene to float upon the water and soften the scale. Shortly after starting up, the steam valves would not close until pushed down by the hooks and there was a strong smell of hot kerosene around the engine; so it was surmised that the kerosene vapor had washed the oil off the valves. After getting rid of the kerosene via the safety-valve route, the engine valves acted properly and the packing did not heat.

By the way, the real cause of the foaming was a worn-out blowoff valve that we were afraid to use often enough. HOWARD WOLCOTT.

Ponca, Neb.

I have had the same kind of trouble as that described by Mr. Noble, on an Ideal engine, and it seemed to be caused by the packing expanding excessively. I now pack the piston in the usual way, drawing up the gland nut with a wrench and then backing off. As we only run ten hours a day, I back off the packing nut every morning until I feel that it is not tight, after which I do not touch the gland until I hear it blowing, when I repack the piston. I have only had trouble with one brand of packing, and with this brand it does no good to draw up on the gland after blowing begins. W. G. WALTERS.

Aurora, Ill.

I think the packing gland is too tight after the new packing has been put in, and for a day or less Mr. Noble should back the gland nuts off till steam starts to blow, then take up enough to stop it; and the next day try to back off some more. In the meantime he should have a small pail of cylinder oil and graphite (there should be enough graphite to make it thick) and every three or four hours for a few days give the rod a good coat of this mixture; then after three or four days, two or three times a day will be enough. He should try this treatment on any rod and see how much longer the packing will last and what a good finish it will put on the rod. FRANK WELLS.

Jeffersonville, Ind.

The trouble with ordinary "soft" packing (no matter how good the quality may be) is that when adjusted with the gland nuts just set to hold the packing in place—say finger-tight—the steam works in behind the packing and exerts a force in exactly the same manner and with the same effect as if the packing gland nuts were drawn too snug, and overheating follows. On the other hand, if the gland nuts are drawn so tight that the steam cannot get behind the packing, it will pinch and the rod will heat. My suggestion as to a remedy is metallic packing. ROBERT E. HICKS.

Houston, Tex.

Discussion on Ammonia-Compressor Diagrams

Regarding the ammonia-compressor diagrams of J. C. Harrison in the Jan. 15 issue, neither set seems to have been taken under correct conditions of suction-gas temperature. The Wolf-Linde compressor is of the wet gas type, in which the frost is carried right up to the compressor, the temperature being regulated by the amount of liquid ammonia carried into the cylinder with the suction gas.

With the temperature of the suction gas shown by diagrams Figs. 1 and 2, the temperature of the cylinder and discharge would be too high, and the ammonia rod would be hot and troublesome. With conditions as revealed by diagrams, Figs. 3 and 4, too much liquid ammonia is being carried with the suction gas, the temperature of suction gas being approximately 4 deg. F. below the boiling point of the ammonia due to a pressure of 24 lb. Better results are obtained when the temperature of the suction gas is about 10 deg. higher than the boiling point of the ammonia due to the suction pressure.

Fig. 1 indicates either incorrect gage readings or a mistake in locating the atmospheric line, as scaling

with a 120-lb. scale shows the suction pressure 24 lb. and the head pressure 140 lb. Fig. 2 shows a larger reëxpansion loss than necessary with this type of compressor and may be due to excessive clearance. Figs. 3 and 4 show the loss in capacity due to too much liquid ammonia entering the cylinder. This is indicated by reëxpansion taking place during 30 per cent. of the suction stroke, being about 25 per cent. more than necessary with a correct suction-gas temperature.

I believe that in this case the compressor cylinder itself was well frosted, as the compression line leans more toward the isothermal curve than in Figs. 1 and 2, indicating that some of the heat of compression was being removed by the extremely cold cylinder walls.

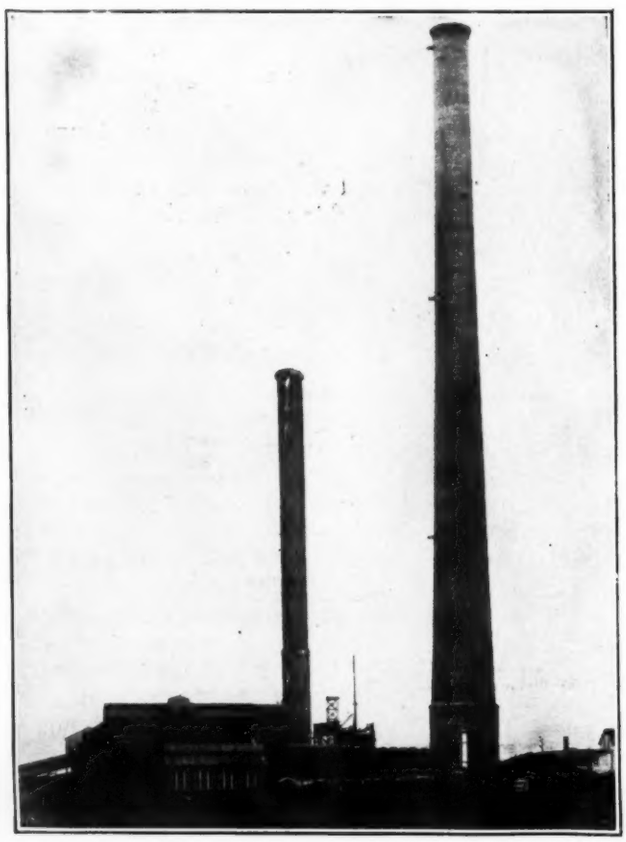
The discharge-valve springs on both ends of the compressor seem to be too strong, although this may be necessary owing to the speed of the compressor, as the normal speed for which this type of compressor was designed is about 50 r.p.m.

I would advise that lighter springs be tried and some diagrams taken with the suction temperature regulated to give a discharge temperature of 120 to 140 deg. F.

New York City. F. G. SCHOENFELD.

Tallest Chimney in the World

In the issue of Jan. 8, 1918, page 56, it is stated that a smelter stack in Japan is 570 ft. tall and that it is claimed to be the highest in the world. I am sending a photograph of



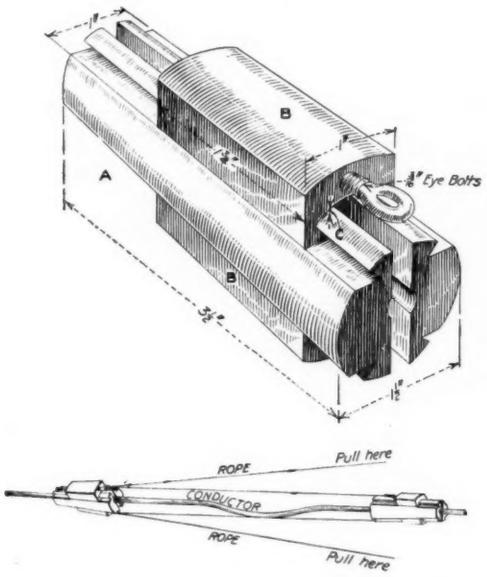
TACOMA, WASH., SMELTER STACK 572 FT. 10 IN. HIGH

one recently completed in Tacoma, Wash., by the Tacoma Smelting Co., the height of which, from top of the concrete base, is 572 ft. 10 in. It is 50 ft. in diameter over-all at the bottom, where the walls are 4½ ft. thick. It tapers to 25 ft. outside diameter at top, with walls 17 in. thick. The chimney is lined and has a 2-in. dead-air space between the lining and walls. The concrete base is 31 ft. thick, and 2,400,000 bricks were used in constructing the chimney. The original contract called for 571 ft., but it was built 1 ft. 10 in. higher. I wish you would publish this in *Power* as we don't want anyone to get away with anything on us. GLENN MARTIN.

Tacoma, Wash.

Wire-Tightening Tool

It is generally a somewhat difficult job, without the use of proper tools, to get a hold on an insulated or a bare wire to take a strain on it without injuring the insulation or kinking the wire, especially if the conductors are of large size. It was to provide a satis-



PARTS AND ASSEMBLY OF WIRE-TIGHTENING TOOL

factory means for putting the proper tension in electrical conductors when they are being run in the open on insulators that the tool shown at *A* in the figure was devised.

The construction of the device is self-explanatory, and the dimensions given are sufficient for anyone to go ahead and make one. The one shown was made from a taper pin 1.5 in. in diameter on the large end and 1 in. on the small end. Eye-bolts in the pieces *B* are used to apply the strain to the conductor. The grooves in the movable parts must be cut of sufficient size to allow the large end of the V on the stationary parts to fit into them as at *C*, or the former will jam on the latter. To take a strain on a wire from two directions two of the tools may be used, spaced at convenient distances apart on the conductor, with a rope run through the eye-bolts to apply the tension, as shown at the bottom of the figure. The dimensions shown in the figure are right for a tool to be used on conductors up to ⅜ in. diameter.

Ozone Park, N. Y. M. P. BERTRANDE.

The buying of War-Saving Stamps has developed a finer sense of thrift and economy among the people.

Inquiries of General Interest

Greater Sensitiveness of Loaded Governors—How does loading an engine governor affect its sensitiveness? W. N. B.

Omitting friction, the sensitiveness of a loaded or unloaded governor would be theoretically the same. But in practice the friction of a governor and its gear may be considerable, and the sensitiveness of a loaded governor is actually much greater than the unloaded one, as the friction is a smaller proportion of the total forces acting on the governor when loaded than when unloaded.

Long Pump-Suction Pipes Objectionable—What are the objections to a long pump-suction pipe? R. H.

Long suction pipes are objectionable because the greater amount of pipe friction to be overcome by the suction pressure requires the pump to make a higher vacuum; the momentum of the suction water at each reversal of the pump, or sudden stoppage of the pump, may be productive of damaging water-hammer; and in addition to having more joints to give trouble from air leakage, with the water taking longer time for its passage through the suction pipe, more air is liberated out of the water, thus impairing the capacity and proper operation of the pump to a greater extent than with a short suction pipe.

Location for Tightener-Idler Pulley—Where should a tightener-idler pulley be placed for increasing the driving capacity of a belt when there is short distance between centers of the main pulleys? H. B. F.

An idler should be employed for increasing the arc of contact of the belt on the smaller pulley rather than for increasing the tension of the belt and should be on the slack side of the belt near the smaller pulley. To minimize friction, the diameter of the idler should be as large as compatible with obtaining the necessary arc of belt contact on the smaller of the main pulleys, and the idler frame should be held to its position by means of screws or other adjustable fastenings.

Disadvantage of Excess Air—What is the disadvantage of excess air to a boiler furnace? R. A. E.

The surplus air has to be heated up to the furnace temperature without adding anything to the combustion, and carries off to the chimney as many units of heat as are required to raise it from the temperature at which it enters the furnace to the temperature at which it enters the uptake, or about 0.24 of one B.t.u. per degree difference of temperature for each pound of excess air. To be sure that each atom of carbon of the fuel will meet with an abundance of oxygen, it is necessary to admit 50 to 100 per cent. more air than is required for theoretically complete combustion, and determining what proportion of excess air is most advantageous is best done by flue-gas analysis.

Deposit of Scale at Girth Seam Over Fire—Where scale is formed by the feed water of a return-tubular boiler why is there greater accumulation of scale at the girth seam over the fire? J. J. O.

Local deposits of scale are generally due to the circulation. In a return-tubular boiler the heat of the fire causes disengagement of steam bubbles that, in rising to the steam space, induce an upward current of the water, which is replaced by a flow along the bottom from the rear of the boiler. The change in the direction of the circulation and also the obstruction offered to flow by the rivets and lap of the joint cause eddies and swirls that include places where the water is quieter and out of which a larger proportion of the suspended matter is precipitated than from water that is moving at higher velocity.

Wasting Live Steam When Used With Exhaust—In a plant where exhaust steam for heating is supplemented by live steam passed through a pressure-reducing valve, less total steam appears to be required from the boilers to do the same heating when no exhaust is used and the heating apparatus is supplied with only live steam. What is the explanation? A. B. C.

The results obtained signify that when the exhaust is used in conjunction with live steam, there must be a waste of more heat than the exhaust is capable of supplying. This may result from escape of steam through the back-pressure relief valve because the heating apparatus is oversupplied, or rejects steam at the relief pressure of the back-pressure valve; or from passage of unused steam through the apparatus and discharging it direct to the atmosphere; or that the excess of steam is received by a vacuum pump that removes more steam than should be necessary for obtaining good circulation in the heating apparatus. When live steam is used to supplement exhaust, a waste is likely to occur unless the discharge pressure of the live-steam pressure-reducing valve is well below the pressure at which the back-pressure relief valve opens, or when unused steam is allowed to escape from the heating apparatus.

Estimate of Chimney Draft—What should be the force of draft, in inches of water, of a brick chimney 120 ft. high with the temperature of the atmosphere 40 deg. F. and temperature of the chimney gases 500 deg. F.? N. G. D.

The force of draft may be found by the following formula, which makes an allowance of 20 per cent. for friction in the chimney:

$$D = 0.42H \times P\left(\frac{1}{t} - \frac{1}{T}\right), \text{ where}$$

D = Force of draft in inches of water shown by the difference of level of water in a U-tube;
H = Height of the chimney in feet;
P = Pressure of atmosphere in pounds per square inch (14.7 at sea level);
t = Absolute temperature of atmosphere (deg. F. + 460);
T = Absolute temperature of gases in the chimney deg. F. + 460);

Substituting gives,

$$D = 0.42 \times 120 \times 14.7\left(\frac{1}{500} - \frac{1}{960}\right) = 0.71 \textit{ in. of water}$$

Slippage and Readjustment of Eccentric—Without indicating an engine or uncovering the valve, how may it be known whether the eccentric of an engine has slipped on the shaft? H. G.

Slippage usually has the appearance of having occurred backward, though in fact due to the shaft having continued in forward rotation while the setscrew or other fastening of the eccentric to the shaft was not sufficient to overcome the resistance that the valve and valve gear offered to their motion. If the initial position of the eccentric cannot be determined by the setscrew impression on the shaft or other marking, then, to test the position, place the engine nearly on the center and turn it forward until steam begins to be admitted as may be seen by opening the throttle a little and observing when steam is seen to issue from an indicator hole or drip-cock in the end of the cylinder. Then place the engine on the other center to see whether the same amount of lead is obtained. If there does not seem to be the same amount of lead, readjust the eccentric forward or backward to compensate for one-half the apparent difference. It does not follow, however, that because the eccentric is turned to the correct position to give equal leads that the valve is properly set, for if the valve rod was not in proper length of adjustment, the other valve events will not be equalized.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—EDITOR.]

Internal-Combustion-Engine Lubrication*

By W. F. OSBORNE

Some of the important facts relating to the lubrication of internal-combustion engines are set forth and discussed.

THE film of oil placed on the cylinder walls by the piston on the compression strokes of an internal-combustion engine lubricates the piston on the explosion stroke. As the piston moves towards the crank, the walls are exposed to the high temperatures of the burning gases; thus the flame comes in contact with the oil film only after it has served its purpose of lubricating the piston on the instroke. The greater part of the damage to the oil film is done during the firing stroke. The oil between the rings and between the piston and cylinder walls also is subjected to the pressure of the burning fuel and thus assists the piston ring in preventing loss of power through leakage of gases into the crank case. If there is any trouble with the lubrication, it will occur on the exhaust stroke, as the oil film on the cylinder wall has just been exposed to the high temperature of the burning gases and has undoubtedly been somewhat damaged. However, if the oil possesses the proper characteristics, some lubricating value remains, which, together with the oil film on the piston itself, lubricates the piston on this stroke.

There are, in the mechanical construction and in the operating conditions of an engine, a number of factors which determine the characteristics of an oil that will satisfactorily meet the requirements cited. Some of the more important of these are: Temperatures in the cylinders, piston clearance, speed, cooling systems, ignition, fuels, carburetion and oiling systems.

Effect of Temperature Conditions

The temperatures existing in the cylinder of a four-stroke-cycle engine as given by Lieut. G. S. Bryan, U. S. N., in his paper on "Motor Cylinder Lubrication," published in the Journal of the Society of Naval Engineers, February, 1915, are as follows:

Maximum temperatures obtained at top of explosion stroke, 2700 deg. F.; minimum temperature during suction stroke, 250 deg. F.; and an average temperature during the complete cycle, 950 deg. F. These are the temperatures of the gases in the cylinder, and not of the cylinder walls.

Basing calculations on an investigation made by the Bureau of Mines in 1912, of the transmission of heat in steam boilers, it would appear that the temperature of the inner surface of the cylinder walls ranges from 55 to 60 deg. higher than that of the circulating water. Later investigations have shown the temperature difference to be as low as 30 deg. in some instances. As long as the water is not boiling, the cylinder-wall temperatures will hardly be much better than 267 deg. F., while at normal circulating-water temperatures of 140 to 150 deg. F., the wall temperatures will probably range from 170 to 210 deg. F. The temperature of the center of the piston head, which in most cases is not water-cooled, runs from 800 to 1300 deg. F.

The maximum temperature of 2700 deg. F. occurs when the piston is practically at dead-center, and the temperature then rapidly drops as the piston moves inward, uncovering the oil film and exposing it to the flame until the end of the stroke. The outer surface of the oil film in contact with the cylinder walls at the comparatively low temperature of between 170 and 210 deg. F. is probably never affected by the high temperatures, but the inner surface of the oil film, directly exposed to the flame, is undoubtedly damaged, probably the greater part being destroyed.

With a maximum gas temperature of 2700 deg. F., and an average temperature of 950 deg. F., as it is impossible to produce a petroleum lubricating oil of any kind having a flash point over 700 deg. F., it would seem that any oil film would be promptly destroyed and that the so-called high-flash oil of 450 deg. F. would afford very little more resistance to burning than a low-flash oil of 325 deg., under these conditions. Either oil will burn if kept in contact with these temperatures for any appreciable time, so that the outer surface of the oil film will be affected, regardless of the flash point of the oil. However, lubricating oils burn comparatively slowly, and in the short period the film is exposed to the flame it will not be completely destroyed if it is of the proper thickness. It would therefore appear that the film must be thick enough to permit of a part being destroyed and at the same time sufficient thickness of good oil being maintained to lubricate the piston and cylinder on the exhaust stroke.

While the high temperatures of the exhaust gases, around 800 deg. F., continue to destroy the film on the exhaust stroke, the advancing piston smears a fresh film of oil over the cylinder's surface, which lubricates the piston for the suction stroke. The cool, fresh charge of fuel, even when mixed with the exhaust gases remaining in the cylinder, does not average over 250 deg. F., so that no damage is done to the oil from high temperatures on this stroke. As the increase in temperature on the compression stroke does not become very great until the piston has completed the greater part of its stroke, there is very little effect on the oil film. An oil to be suitable should maintain a film of a proper thickness under the working temperatures of the cylinder.

The Effect of Piston Clearance

The seal between the pistons and cylinders obtained by mechanical means is secured at the expense of greatly increased friction. In fact, the rings can be so tight that the engine cannot be turned over at all. A more desirable form of seal can be secured by making use of the film of lubricating oil necessarily existing for lubrication. As the piston advances, a supply of oil builds up on the edge of the piston head and on the advancing side of the rings, which opposes the force of the compressed gases, and if the lubricating oil has sufficient strength or viscosity to resist the force of the gases, a perfect seal is obtained.

The benefits secured by a perfect seal maintained by the lubricating oil are: Minimum lubricating-oil consumption; minimum fuel consumption, by preventing leakage of fuel past the rings on compression and waste of power on firing stroke; minimum friction, through the use of looser-fitting pistons and rings working on a lubricating film; minimum carbon, due to minimum quantity of oil working into the combustion space. Where a crank-case oiling system is provided, a perfect seal, by preventing the hot gases from reaching the crank case, maintains lower oil temperatures and thus prevents excessive bearing and cooling-water temperatures. In the operation of crank-case oiled engines, a perfect seal is of great benefit, as it prevents liquid fuel or vapors from passing the rings and later condensing into a liquid in the crank case, thus thinning down the oil and destroying it.

Cause of Thinning Down of Oil

Some elaborate experiments were made in 1911 to determine the cause of this thinning down of the oil. During these experiments many different kinds of oil were run to the breaking point in a Singer motor. An examination before and after the test showed, in every case, that the body of the oil had become lighter and that the flash point had been lowered, sometimes to the surprisingly low point of 150 deg. F., whereas the original oil had a flash point of 450 deg. F. To determine whether this was caused from the breaking down of the oil or its being thinned by the amount of fuel working past the piston rings, tests were made, using benzol as a fuel. The presence of benzol is readily detected in lubricating oil, whereas gasoline or kerosene and the products of the decomposition of a petroleum oil, which are similar to gasoline, are not. These

*Abstract from a paper published in January, 1918, issue of the National Gas Engine Association's Bulletin.

tests established the fact that the gas leaked past the piston rings, evidently afterward condensing and affecting the motor oil. As high as 3 per cent. of benzol was found in the motor oil after four hours' running. The effect of this admixture of fuel is to lower the flash and fire, increase the Baumé gravity and lower the viscosity. Many tests made in subsequent years confirm these general facts.

Judging from these tests it would appear that a large proportion of motors of this type operate on an oil that is quite different from the new oil introduced into the engine. This varying condition of the oil is directly the result of the condition of the engine, and the condition of the engine, as time goes on, is the result of the changed condition of the lubricating oil. What becomes of the argument that a high-flash oil is necessary to properly lubricate motors, when this same oil promptly has a flash point of 200 deg. F. when the motor is warmed up and operating?

The Effect of Time of Complete Cycle

A thin film of oil smeared on a hot (300 deg. F.) piece of iron or steel will burn several seconds if ignited, so that even with the engine running as slowly as 100 r.p.m., if the oil film is of reasonable thickness it will not be entirely destroyed. When the speed is increased to 1000 r.p.m., as in the case of automobiles, which allows a total time of 0.06 of a second, and even less with higher speed motors, for the lubricating-oil film to be exposed to the burning gases, the viscosity of the oil, and consequently the thickness of the film, can be reduced considerably without meeting with trouble. In any case the viscosity should be high enough to maintain a film of such thickness that it will not be destroyed on the firing and exhaust strokes.

Air-cooled motors, such as motor-cycle engines, air-plane engines and one or two types of automobile engines, naturally run with very hot cylinders. With circulating-water systems it is possible to hold the cylinder-wall temperatures at a much lower point, and the required viscosity of a suitable oil will be higher or lower as the cooling water leaving the cylinder jacket is hotter or cooler. With a given oil the cooler the engine the better will be the seal, owing to the increased viscosity of the oil.

If ignition takes place at exactly the proper time, resulting in the most complete combustion possible of the fuel mixture supplied, the temperature falls off rapidly. If the spark is retarded, a slower and later burning results, extending over a considerable portion of the stroke. Continuous retarded-spark operation raises the temperature of the cylinder walls and the cooling water, thinning down the oil and frequently reducing its viscosity to the dangerous point.

Effect of Different Fuels

Natural gas, blast-furnace gas, producer gas and coke-oven gas, being comparatively slow-burning, do not produce high initial temperatures, but expose the oil to more severe temperature conditions. These slow-burning gases are generally used in comparatively low-speed engines on account of the time required for complete combustion, and a thicker oil film on the walls is necessary for protection against the long exposure to high temperatures.

Kerosene being slow burning, slower than gasoline, permits of higher compression, and requiring somewhat higher circulating-water temperatures, imposes a severe service on the lubricating oil, which must have exceptionally good body and lubricating qualities to stand up to the requirements.

The question of complete carburetion or vaporization of the fuel has great bearing on the efficiency of lubrication. The ideal condition is, of course, high initial pressure, and very early, complete combustion, approaching the gunpowder explosion. In this case the maximum temperatures are obtained when the piston completely covers the working surface of the cylinders and the lubricating film is not exposed to these extremely high temperatures. If the fuel is not completely vaporized and thoroughly mixed with the proper proportion of air, slow burning occurs, with the bad effects indicated in the foregoing.

The method of supplying the oil to the cylinders and bearings affects somewhat the viscosity of the oil that can be used, in that the suitable oil must be thin enough to flow to the parts to be lubricated from the point of supply; but instead of selecting an oil that is suitable for working in the system provided, it seems much better to select an oil suitable for the parts to be lubricated and then arrange the oiling system to properly handle that oil.

The most discussed, perhaps because it is the most visible, effect of unsuitable oil, is the carbon deposit in the combustion space, on the valves, the piston head and behind the rings. It is generally assumed that all carbon deposits are caused by poor oil or by poor gasoline, whereas the carbon deposits may be caused, and probably in many cases are caused, by the use of unsuitable oil or imperfect carburetion. An analysis of the carbon deposits in a cylinder generally shows the presence of considerable quantities of dust, drawn in through the air intake, and rust held together by a small quantity of oil.

A motor oil should consist of refined and filtered mineral oils or mixtures, having a cold test of not over 25 deg. F., fully suitable for use in internal-combustion engines. An oil meeting these specifications would be perfectly satisfactory when used in an engine for which it was suitable, its suitability being largely determined by its viscosity.

There are a number of tests that are used for the purpose of determining the suitability of a lubricating oil, which it might be well to mention, together with the qualities they determine.

The gravity reading is merely an indication of the crude from which a lubricant is refined, and is no indication of its lubricating value for internal-combustion cylinders.

Flash and fire tests are no indication of the ability of an oil to stand up under the working temperatures of the cylinders. As previously stated, the temperatures in the cylinders are far beyond the highest possible flash tests of any lubricating oil, and a high-flash oil would afford very little more resistance to destruction than a low-flash-test oil.

The pour test is an indication of the temperature at which the oil will flow, and where the engine is operated under conditions of temperature below 30 deg. F. the pour test of the oil is of considerable importance.

Viscosity of Oils

The viscosity reading is the measure of the body of the oil, and may also be considered as a measure of the thickness of the film of oil maintained on the cylinder walls. It is also an indication of the ability of the oil to resist the pressure of the explosion gases, which tend to force their way past the piston rings. In other words, the higher the viscosity the greater will be the ability of the oil to withstand the high temperatures encountered and the better would be the effect in maintaining the piston seal.

The average purchaser of motor oils, having no data on their actual viscosity readings, must select the oil according to the general trade name of light, medium, heavy and extra-heavy motor oils. These terms at present having a somewhat indefinite meaning, it would appear that there is a great need for the standardization of viscosity, and the following suggestions are made, based on the viscosity of 100 deg. F., Saybolt Universal Viscosimeter: Motor oil, light, from 170 to 230 sec.; medium, from 270 to 330 sec.; heavy, from 470 to 530 sec.; extra-heavy, from 720 to 780 seconds.

Color in itself is no indication of the lubricating value of an oil. About the only information as to its value that can be obtained from noting the color is whether or not the oil is contaminated by moisture or foreign matter.

The author realizes that there are a number of additional influences affecting the selection of suitable oils, but it is hoped that the points brought out will be of some benefit to those interested in the use and purchase of internal-combustion cylinder oils.

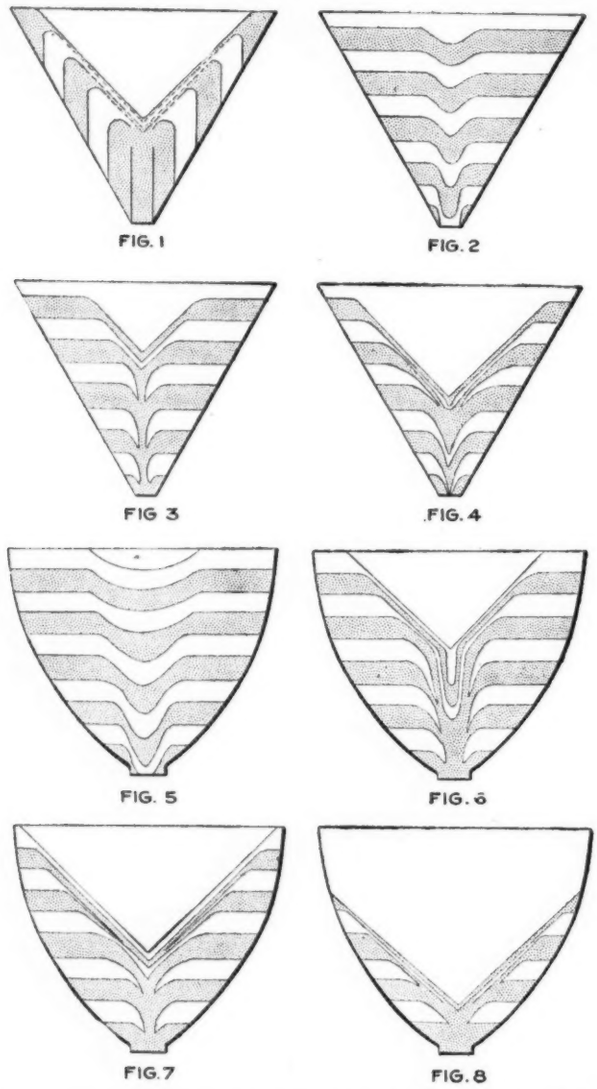
Under the Iowa statute which empowers cities to fix the rates to be charged by electric-power companies and other public utilities, and under a power company's franchise, fixing a schedule of charges on the basis of kilowatt consumption, without any provision for meter charges, the company is not entitled to increase its service charges by imposing a meter fee or by any other subterfuge. (Iowa Supreme Court, Iowa Railway and Light Co. vs. Jones Auto Co., 164 Northwestern Reporter, 780.)

Mixing Coal in Storage*

BY GEORGE FREDERICK ZIMMER

Because of the problem of mixing culm and other fine coals with bituminous coal preparatory to use in boilers, the following article should be of especial interest to American engineers.

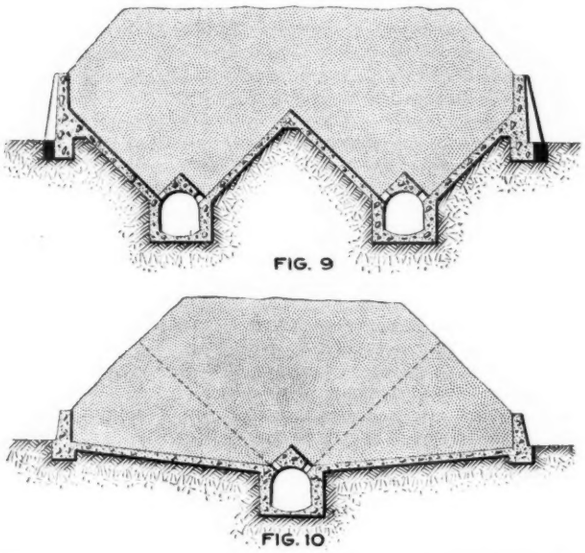
THE writer will here deal with the subject of accumulating coal in such a way that it can be reclaimed from the base of the pile. This method is more scientific and has the advantage that not only is accumulation of the small coal prevented, but the coal at the deepest part of the pile is kept just sufficiently in motion for the bulk to be slightly broken every time coal is withdrawn, two advantages that minimize spontaneous combustion and therefore make a deeper or higher pile admissible with a sufficient degree of safety. This is important if the available storage area is limited, as is often the case in plants within the precincts of large cities.



FIGS. 1 TO 8. SHOWING MOVEMENT OF COAL AS IT RUNS OUT OF VARIOUS SHAPED BUNKERS AS REVEALED BY COLORED MATERIAL DEPOSITED IN ALTERNATE LAYERS

Concerning the movement of the coal in a hopper pocket, it might not here be out of place to record the results of some tests made by the writer. The diagram, Fig. 1, shows the movement of a granular material, which was deposited in alternate vertical layers of different color, during withdrawal; while Figs. 2 to 4 show three stages of a similar test where the material was arranged in alternate horizontal layers. The movement in bunkers of the form now frequently employed is shown in Figs. 5 to 8.

As the diameter of the descending column in the bunker depends upon the size of the outlet, it is well to make this as large as possible and withdraw the coal relatively slowly by employing mechanical feeding devices. A large outlet is advantageous for a twofold object; namely, the slowly descending column of coal will have a ventilating or cooling effect if there should be a tendency to heat, and a larger outlet will prevent, or at least lessen, the tendency for large pieces to bridge or cave and cause a stoppage in the coal supply through the outlet.



FIGS. 9 AND 10. CONCRETE BUNKERS WHICH DROP COAL INTO CARS LOCATED IN TUNNELS BENEATH THE PILE

The diagrams give a clear picture of what takes place, and if the sides of the hoppers are chosen of a more shallow or even a somewhat more acute angle, it will not alter the proceedings; as soon as a funnel-shaped depression has been formed of the angle of repose of the coal, the pieces around the crater will roll down and descend.

The experiments were made with a model having a glass front, but in practice the same process can be proved to take place, for if the upper layer of coal is limewashed, this washed surface will not be disturbed beyond the formation of a crater; that is, the central column will be withdrawn from the bunkers before the whitewashed pieces begin to descend, and they will presently appear through the outlet. This shows, incidentally, that the coal deposited last in the bunker will mix with some of that stowed earlier, so that we might almost depend on having in the descent an average sample of the contents of the bunker, provided the outlet is big enough. Where gas pipes are used in such coal stores for the reception of thermometers—to record any change in the temperature—these pipes remain in an upright position as the coal-level in the bunker becomes lower, until practically two-thirds of the coal which used to hold them has been withdrawn.

*From an article in the Jan. 18, 1918, issue of "Engineering" (London), entitled Modern Methods for the Storage of Coal.

Coöperation an Essential Element in the Winning of the War

By E. W. RICE, JR.
President, General Electric Co. and the A. I. E. E.

Abstract from a lecture delivered Feb. 15, at the dinner of the sixth annual midwinter convention of the American Institute of Electrical Engineers held in New York City. The speaker outlines what the country has already accomplished since entering the war and then points out the great need of coöperation between the industrial organizations of the country, and between these organizations and the Government in order that the maximum output of brains, labor and material may be obtained.

THERE was never a time in the history of the world when work was more needed and when talking is only justified which may help forward the great work at hand. We all know what that great job is—the winning of the war. Everything else must wait and take a back seat until that job is done.

We were all greatly encouraged and thrilled during the early months of the war by the patriotic attitude of Congress, which supported the Administration in an unprecedented manner, without distinction of party.

Activities This Country Has Started

The two great Liberty Loans, aggregating between five and six billion dollars, were voted and raised with the patriotic and enthusiastic support of all the country, and we are told that when history has been written wicked Wall Street will deserve a decoration for its patriotic and efficient assistance. A great scheme of taxation, more drastic and bearing more heavily upon the wealth of the country than anything known in our history, has been passed and will be loyally supported even by those who are most heavily hit.

The selective-draft system was prepared and put into operation and accepted by the country in a truly magnificent manner. The Red Cross has been reorganized and an enormous amount raised by voluntary subscriptions and is well started on its beneficent and valuable mission. The Knights of Columbus are also doing magnificent work in a similar field. I will not take your time to sketch any further the tremendous activities which this country has started during the past year.

In view of this record of accomplishment and our truly splendid start in the war, why has this feeling of nervousness come over the country? Why has Congress suddenly changed its attitude of unquestioning support to one of investigation and criticism? What does it all mean? Is it true that we are making a failure of the job?

It seems clear to me that we have not made a failure and that everything is moving along as well as we had a right to expect under all the circumstances. When we consider that less than a year ago, our nation of a hundred million of people, entirely unprepared for war, with institutions and traditions adapted only to the conditions of profound peace, was thrust into this greatest of enterprises, I think we have already accomplished wonders and that we should not be discouraged. In spite of eminent authority a million men cannot spring to arms over night, nor can dreadnaughts, destroyers, submarines, anti-submarine devices, heavy ordnance and all the great mechanism of war be produced in a day, in a month, or even in a year, no matter how much we pray or "cuss" or work. Business men, and especially engineers and manufacturers who understand the nature of the equipment required for this conflict, however, must appreciate that our fundamental, and let us hope not fatal mistake, is that we waited until the war was thrust upon us before we started to get ready.

I think that a little reflection will make it clear that the mistakes we have made since we started in the war, however numerous or avoidable, are in the aggregate negligible compared with the overwhelming mistake of failure to prepare for the war during 1915 and 1916. That precious time has been lost forever, and no effort or time, criticism or talk can cancel that mistake and give us back the lost time. We must expend untold billions and we must make superhuman efforts, but we must also be patient and realize that inconsiderate haste is likely to result in added friction, lost motion, false starts and a general retardation of our program.

Done Well Since We Started in the War

While it would seem that, considering our history and our type of government, with its checks and balances, we have done fairly well since we started in the war, we realize that we have fallen short of what we would like to have accomplished, and we should not be satisfied nor should constructive criticism be discouraged. I believe, however, that we should not become unduly disturbed, but rather be encouraged at the prospect. "While there is life there is hope," and the very fact that the country has energy enough to kick violently while it is working, clearly demonstrates that there is no possibility of dissolution or thought of defeat.

It seems quite probable that the questioning attitude of the country today is due more than anything else to a growing fear that the full ability, wisdom and experience of the country is not being properly utilized. When at war every important force in our nation must be enlisted to the fullest extent and in the most efficient manner. The support of the country has been magnificent. Would not this confidence be greatly strengthened if those in political control would look beyond their party and take into the service of the nation its strongest men without reference to political affiliation?

There are plenty of such men who are willing to help the country, and the country wants them put to work worthy of their records and abilities, not under dictation but as partners of our great enterprise. England has met the situation by a so-called Coalition Government. Why can't we do something similar?

Large Number Volunteer for Service

The country is greatly encouraged at the large number of able men, prominent in business and other walks of life, who have volunteered for service in various departments of the Government and who have been accepted and set to work. This policy should be encouraged, as the more it is followed the better the country will be satisfied and the sooner we will win the war.

It is essential that the men who are charged with enormous responsibilities in our Governmental enterprises have the confidence of the country, as their orders, no matter how drastic or arbitrary or apparently unnecessary, should be followed with confidence. At the present time orders are patriotically obeyed, but with some misgiving. There is no lack of confidence in their good intentions and character, but there is some questioning of their wisdom and practical experience.

Every organization must demonstrate what it can do to help the country in its hour of need. Every organization, whether of capital, labor, manufacture or business, and every individual must be subjected to the test of whether it is doing its best and most effective work to win the war. This will be the only and supreme test. Every individual

who fails to put forth the maximum effort in the most efficient manner must be brought into line.

It is obvious that no single element by itself can win the war. Capital alone is helpless; labor alone is equally helpless. The Navy cannot win without the help of the Army, and both are helpless without ships. The sacrifices cannot be made by capital alone, or by labor alone, but must be distributed on a fair basis.

The test of patriotism will be the willingness to work, each in his own sphere, to the absolute limit. We need the maximum output of brains, labor and material; the country demands it, and the country will see that it is obtained. Any man or organization of men that stands in the way of the purpose which this country has set for itself will be eventually crushed.

It is manifestly impossible to build up a new organization that will operate satisfactorily at once. It has taken many years to build and perfect the great industrial organizations of our country. The transfer of a man to Government service does not change his character or necessarily increase his efficiency. After any organization has been brought into existence, time is required for the different units to learn their duties and particularly to learn how to coöperate with one another.

It takes time for us to get over our ideas and practices, based upon our competitive conditions and education. We are now to forget our education in competition, and think of nothing but coöperation; in other words, of what is best to increase the country's production as a whole, for that is vital in winning the war.

It is obvious that the Navy and Army cannot be built up without drawing upon the organization and facilities of the country and that their activities cannot be maintained without an efficient industrial organization constantly at work behind them in this country. Therefore, our Government, as well as ourselves, must never forget that the preservation of the country's industries in the highest state of efficiency is a vital matter.

I like the President's expression, "Spirit of accommodation," for that is an essential element of coöperation.

Now I wish to emphasize the fact that it takes time to produce really efficient coöperation. No new organization can possibly work as smoothly and effectively as one which has had time to become perfected. Moreover, coöperation in Washington between departments will not entirely settle the matter. We have a duty to perform. There must be coöperation among the industries. We must forget to compete and learn to coöperate with other units.

But this is not all; we must have coöperation between the Government and industries, and to be effective, this means that each must be a party to the coöperation. It cannot be a "lion and lamb" sort of affair. If the Governmental heads use their vast power arbitrarily and unwisely, they can easily cripple the industries of the country, and thus delay victory for years.

I believe that the problems facing us will be successfully solved in time, but we need more coöperation, more of the spirit of accommodation, all our patience and wisdom and, above all, a willingness to work to the limit.

We must discipline ourselves until a shirker in any field of useful effort will be regarded with the same contempt as a shirker in the military service of the country, for there is no difference, or if there is any difference, a shirker behind the lines is worse than one in the trenches.

It has taken a world tragedy, the tragedy of war, to arouse the nation to an appreciation of the value of its technical men. This great strife is not, as in other ages, a contest of brute force in which the bulkiest muscle is bound to win, but it is a battle of intellectual giants struggling for supremacy in destructive creation, and protective and defensive development. The civil engineer, the mechanical engineer, the electrical engineer, the mining engineer, the chemical engineer, the aëronautic engineer, the marine engineer—a great coöperative brotherhood working for peace and victory—have cast their skill, knowledge and effort into a crucible from which our country is drawing the metal from which victory will be fabricated and a world peace be secured.—*American Association of Engineers.*

Ships, Ships, and More Ships

The question of whether we are going to allow our country to become a German province has now to be answered. And it must be answered by ships, and ships, and more ships. It must be answered now—at this moment. We have got to decide instantly whether we are going to live up to our promises to our Allies—to England and her colonies, that are putting their last men into their armies; to France, that is in desperate straits; to Italy, which has so bravely pulled herself together after an almost withering defeat.

Without ships we cannot win the war; we cannot justify the faith with which our Allies honor us. Wanting ships, we can send no more men to the battlefield; we cannot even maintain the American soldiers who have reached the other side and who depend for their very lives on the support of their fellow-citizens at home.

To build ships we must have men. Our shipyards will need, must have, 250,000 workers. Men of all trades who can work in wood, iron or steel with a fair degree of skill will be welcomed by the Government and by the Shipping Board, so long as they are willing to serve with faith, loyalty and perseverance. Workmen in our shipyards to-day are absolutely vital to our military success, and those who answer the call will be just as truly defenders of our country and its Allies as are our soldiers on the fighting front.

The men required are not asked to give up their jobs and move somewhere else immediately. That would cause confusion. What is asked is that every man who stands ready to go to work building ships when the United States Shipping Board asks him to, shall now enroll in the United States Shipyard Volunteers of the Public Service Reserve. Such enrollment will include registration and an examination as to fitness for the work. Application for enrollment can be made at any office of the United States Employment Service, and such offices are now being established all over the country.

If there is no enrollment agent of the Public Service Reserve in your community, see the local representative of the State Council of Defense, or write to Edward N. Hurley, Chairman, U. S. Shipping Board, Washington, D. C.

Culm and Bituminous Coal as Fuel

In an address delivered before the manufacturers and business men of Reading, Penn., William P. Frey, fuel engineer of the Lehigh Coal and Navigation Co., gave some interesting figures relating to the use of a mixture of anthracite culm and bituminous coal as a fuel. The tests from which his figures were obtained were conducted at the plant of the Carpenter Steel Co., Reading, Penn., from Nov. 19 to Nov. 24, 1917. The following excerpts are taken from Mr. Frey's address:

Given the large amount of anthracite culm available for immediate use and the great shortage of bituminous coal, is there a possibility of combining the two fuels into one? What are the proportions to be used, and what will be the resulting effects practically and economically?

The first question is answered by mixing soft and hard coal mechanically or by hand and developing a firing practice to burn the combination of the two. In a small plant the mixing may be done very much like the mixing of sand, gravel and cement, using a box or wheelbarrow as a measure. The better the mixing the better will be the results. Accordingly, all lumps that will not pass through 1½-in. round mesh should be crushed to smaller sizes. In large plants this crushing can be done through a rotary crusher. The mechanical mixing can be done in many different ways —common dump pockets, screw conveyors, paddle mixers, rotary drums, spray-out mixing devices like revolving tables with scraper arms or shaking tables with collecting chutes and spouts.

If the mixing is done properly, firing practice need not be changed, though there should be a tendency to damp off fires. Firing in thin layers will give better results but not quite so high ratings. Grate bars up to ½-in. air space can be used, as the culm bakes with the soft coal to a coarsely granulated material having the appearance of coke, which will not fall into the ashpit.

In all these tests the mixing was done by hand. Beginning with bituminous coal only, culm was added in increasing amounts until the mixture consisted of 66.7 per cent. of bituminous coal and 33.3 per cent. of culm. The results obtained are given in Tables I and II.

TABLE I. RESULTS OBTAINED USING NATURAL DRAFT

Average feed-water temperature	198 deg. F.
Average steam pressure, gage	112.5 lb
Average stack draft, water gage	0.4 in.
Cost of bituminous coal per short ton, delivered	$4.60
Cost of anthracite culm per short ton, delivered	$1.90

Bituminous Coal Per Cent.	Culm Per Cent.	Equiv. Evaporation from and at 212 Deg. F. per Pound of Dry Coal Pounds	Boiler Rating Per Cent.	Boiler Efficiency Per Cent.	Cost per Boiler-hp. Per Hour Cents
100.00	.....	10.03	112	69	0.78
80.00	20.00	9.47	106	68	0.73
75.00	25.00	8.76	96	64	0.75
66.67	33.33	7.34	80	55	0.89

TABLE II. RESULTS OBTAINED USING FORCED DRAFT

Average feed-water temperature	198 deg. F.
Average steam pressure, gage	112 lb.
Average stack draft, water gage	0.15 in.
Cost of bituminous coal per short ton, delivered	$4.60
Cost of anthracite culm per short ton, delivered	$1.90

Bituminous Coal Per Cent.	Culm Per Cent.	Equiv. Evaporation from and at 212 Deg. F. per Pound of Dry Coal Pounds	Boiler Rating Per Cent.	Boiler Efficiency Per Cent.	Cost per Boiler-hp. Per Hour Cents
100	.....	10.80	140	75	0.73
65	35	9.90	112	74	0.63
50	50	8.42	96	66	0.65

The boiler used was a Newburgh fire-tube boiler, having 1549 sq.ft. of heating surface and 32.25 sq.ft. of grate surface. Forced draft was supplied by two calibrated Parson blowers, the steam used by them being deducted to obtain the data in Table II.

Chemical analysis of the bituminous coal showed 2.41 per cent. of moisture, 9.66 per cent. of ash, and 17.34 per cent. of volatile matter. The heating value was 14,000 B.t.u. per pound of dry coal. Similar analysis of the culm showed 9.65 per cent. of moisture and 25.60 per cent. of ash. The culm was clean and its heating value was 10,800 B.t.u. per pound of dry coal.

The tests were run under ordinary normal conditions, without overworking the firemen, and all the test results are given in the tables. The Carpenter Steel Co. ran two check tests, and their results agreed very closely with those shown. The points to be observed are that with natural draft at least 20 per cent. of culm should be used, and if forced draft is employed, the amount of culm in the mixture should be increased to at least 35 per cent.

National War Savings Committee of New York

The method of procedure followed by divisional chairmen of the Commercial, Industrial and Professional groups of the National War Savings Committee of New York is about as follows:

The chairman, immediately upon his selection, proceeds to organize his division by appointing as follows—provided his group is of sufficient size to warrant a duplication of the state organization: vice-chairman, secretary, manager of publicity, manager of speakers' bureau, manager of war-savings societies, executive committee of 3 or 4, managing committee of 15 or 20. As soon as possible, the chairman sends to everyone in his division a letter urging all firms and corporations, co-partnerships or individuals doing business, to take out selling agencies. The letter should cover the following points:

1. The Government is anxious to make War-Savings Stamps and Thrift Stamps the easiest things in the world to buy, the object being twofold: First, to obtain funds to carry on the war and second, to encourage the habit of economy among the people.

2. No capital is required to become Treasury Department agents—merely the investment of a few dollars in stamps, which can be obtained from the postman or post office after receiving appointment as an agent, and that the stamps, which are sold at cost to employees, members of the firm or to the general public, may be replenished from time to time, depending on requirements.

3. After an application has been filled out in the name of an individual and returned to the chairman direct or to state headquarters for Greater New York, 51 Chambers St., New York, a full supply of posters, literature and information regarding sale of these stamps will be sent to the applicant.

4. It is the duty of all to apply for agencies to sell these stamps, even if, as in some cases, only a few dollars' worth of stamps will be sold.

5. Foremen and department managers should be induced to become selling agents, as a greater interest is usually maintained when the employee is the personal representative of the Treasury Department and not the employer.

A few days after a general letter has been sent out, the members of the committee generally make personal calls on all those in their divisions, urging them to carry out to the fullest extent of their ability the suggestions contained in the letter.

Quotas are assigned to the various trades, and in order that these may be made on a fair basis, divisional chairmen send in, as soon as their committees are completed, to the vice-chairman of the Pioneer Division, approximate statements as to the number of employees in their group.

When 100 per cent. of all the firms in a division have become selling agents, it is suggested that committeemen secure members for the United States Government War-Savings Limit Investment Society of New York. This field is limited, however, to employers and principals, so that no very strenuous campaign is necessary to secure membership.

The principal idea of the Limit Club is that every individual who can possibly afford to take the limit allowed by law ($1000 at maturity, which costs only $826 in February, 1918, $828 in March, etc.) do so.

All employers are urged to start their employees saving by the gift of a 25c. Thrift Stamp and card, or the gift of the sixteenth stamp in order to complete the Thrift Card, or—as in some cases it has been done—by the gift of both the first and last Thrift Stamp for their employees. Various schemes can be worked out which will stimulate the sale of stamps among employees.

Food Administration on Ammonia and Ice

In view of the discussion of the Food Administration's ruling and desires relative to ammonia and ice harvest, the following letter from the Administration is of interest:

Your [*Power's*] letter of Feb. 5 addressed to Mr. Hoover on the subject of the ice industry has been referred to this division for reply, as the matters therein mentioned come directly within our jurisdiction, and we take pleasure in giving you below the Food Administration's position on the subject.

It is our desire that every possible ton of natural ice be harvested and stored now, in order to displace a similar amount of artificial ice and thereby permit of the diversion of ammonia from the manufacture of artificial ice to the making of ammunition for our soldiers. There is serious danger of a shortage of ammonia, and ice producers are not only serving their country by heeding our request to store natural ice, but they are actually protecting their trade and insuring their customers against a serious misfortune, which might follow in the event that the War Department felt it necessary to commandeer a considerable amount of ammonia and thereby materially curtail the manufacture of artificial ice. We hope and expect that by the coöperation of all parties in interest, and by careful conservation of the limited supply, it will be possible to avert a depleted ice supply during this year, but this possibility must be kept constantly in mind.

In your letter you referred to a conversation with a member of the committee of New York ice men, which, some time ago, was in conference with officials of the Food Administration. We do not see how any member of this committee could take the position that "he does not know what Washington wants," for we thought our position was made very plain, and men representing 96 per cent. of the ice-producing capacity of New York City have signed agreements whereby an additional million tons of natural ice is being harvested in New York today. This will result in the saving of approximately two hundred thousand pounds of ammonia and will guarantee that New York City will not suffer an ice famine this summer and that the people will not have to pay exorbitant prices for ice.

As you know, nearly all ice factories have large storage rooms, which they fill by operating at capacity during the winter months, in order to have ice in the summer to take care of their peak load. In general, it is not desired to stop the filling of these rooms. However, it is desired that wherever possible, they be filled with natural ice instead of the artificial article, in order to save as much ammonia as possible.

It is also the case that in most communities there are more ice factories than are necessary to supply the trade, and there is a consequent waste of ammonia and fuel, duplication of delivery service and a general economic waste. We are asking that wherever possible, this condition be cured by having the individual firms enter into a voluntary agreement with the Food Administrator, whereby a few of these plants may operate at capacity and the others be shut down, the plants which are closed to be furnished with ice for their customers by those in operation at practically the cost of manufacture.

We are restricting the supply of ammonia for ice-producing plants and refrigerating plants to their legitimate 60-day requirements, in order to insure against the hoarding of this chemical, and are only allowing the sale of ammonia for new plants when we can be convinced of their urgent necessity in the community where it is proposed to erect them.

With regard to your suggestion that it may be unwise to fill up cars with ice and thus add to the congestion of the railroads, we beg to advise that most of this ice is stored very close to the point where it is harvested and that it will add very little to the difficulties of the transportation situation. It can be hauled the short distance necessary in old cars which are not suitable for through traffic, and will not, in any event, seriously affect the transportation system. We might add that a general embargo-lifting order was issued on Feb. 11 by the Car Service Commission, covering about 75 or 80 different seasonal commodities, which would indicate that the railroad situation is improving in a very marked degree, and that no one need worry greatly about the effect of the natural-ice harvest on railroad congestion.

We trust that this gives you sufficient information, but if there is any point that we have not covered or on which you desire further advice, we shall be glad to have you call on us. The Food Administration appreciates your attitude and desire to be of assistance to us in this matter.

U. S. Food Administration,
Charles W. Merrill, Division of Chemicals.

Annual Exhibit of Evening Work at Pratt Institute

Thursday evening, Mar. 7, will be "Visitors' Night" at the School of Science and Technology of Pratt Institute, Brooklyn. From 8 to 9 o'clock all the shops, laboratories and drawing rooms of the school will be open to the public, giving an opportunity to those interested in industrial education to observe the students at work in the various courses and to inspect the results and methods as well as the equipment and general facilities of the institute for conducting this kind of industrial training.

The school provides instruction in industrial electricity, technical chemistry, mechanical drawing and machine design, strength of materials, stationary engineering and power-plant machinery, internal-combustion engine work, machine work and toolmaking, forge work, carpentry and building, patternmaking, and trade teaching for the training of skilled workmen who desire to prepare themselves for the teaching of their trades. A special feature of the work this year is the organization of a number of new courses to meet the extraordinary demands for skilled mechanics arising from the war. These courses are boat woodworking, ship drafting, marine-engine operation, and gasoline-engine operation for men desiring to enter the aviation service.

This school is now giving instruction in its evening courses to more than 1300 men who are regularly employed in various vocations and who use these courses as a means to prepare themselves for more effective service.

This will be the only public exhibit of the work of this school held this year.

A 35,000-Kw. Turbine Is Wrecked in Boston Station

About 4:55 p.m., Thursday, Feb. 14, the 35,000-kw. horizontal single-cylinder steam turbine in the O Street Station of the Boston Elevated Railways Co. exploded, so completely wrecking the machine that it will be sold for junk as it stands, it is reported. Fortunately no one was killed or injured. The trouble developed in the low-pressure stages—the 17th, it is believed. All diaphragms and wheels, together with the blades from this stage on to the 20th, were fractured and broken in many pieces and released with such force as to smash away the whole top half of the low-pressure end of the casing.

The initial cause of the accident is, at this writing, thought to be due to excessive steam pressure between the diaphragm and the 17th wheel concaving the diaphragm, causing it to foul the wheel, closing up the buckets and in this way increasing the steam pressure at this point until the next diaphragm was similarly affected, when the whole low-pressure end let go.

The accident occurred at a time when 27,500 kw. carried by engines in another station of the Railways Co. dropped their load. Assumably, the wrecked turbine tried to take all of this load, opening its secondary valve to get all the high-pressure steam available.

A member of the *Power* staff is, at this writing, in Boston endeavoring to get details of the accident.

One of the tendencies of the present day is to overdo the stop-watch and the watch-dog method. Efficiency of product does not lie in that direction. It is not right to imagine that the men have no other interest in the success of the undertaking than to watch the hands of the clock go round.

New Publications

BOILER ROOM ECONOMICS—By A. L. Potter and S. L. Simmering. Dean Engineering Experiment Station, Kansas State Agricultural College, Assistant Professor of Steam and Gas Engineering, Engineering Experiment Station, Kansas State Agricultural College.

Boiler Room Economics is the title of Bulletin No. 2, originally published in 1914, but which the Agricultural College is again circulating in the hope that the contents may be of material aid in assisting in the campaign to cut down the waste in the use of coal in boiler furnaces. The bulletin gives considerable cost data, which of course need some modification at this time, owing to the changes in the market brought about by the war. The bulletin deals with boilers, pumps and injectors, feed-water heating and purification, stokers, economizers and superheaters, and the subdivisions of each of these subjects.

THE CALORIFIC POWER OF FUELS—By Herman Poole. Third edition. Rewritten by Robert Thurston Kent, M. E., New York. John Wiley & Sons, Inc. Pages, 627; illustrated. Price, $3.

Since the original publication of this work in 1900 the available information upon the subject has multiplied to such an extent that its practical rewriting was necessary. This rewriting was entrusted to Robert Thurston Kent, M. E. It deals with calorimetry in four chapters, with solid, liquid and gaseous fuels in a chapter each, devoting then a chapter to the combustion of coal and another to the calorific power of coal burned under steam boilers. The final chapter treats of the analysis and measurement of the products of combustion. English units have been substituted for the metric units of the original volume. The rewriting appears to have been well done, and the book presents, in an attractive form, information that is very timely.

INTERNAL - COMBUSTION - ENGINE MANUAL. By F. W. Sterling. Published by R. Beresford, Washington, D. C., 1917. Cloth; 6 x 9 in.; 168 pages; 92 illustrations. Price, $2.

This is the fourth edition of this book; it has been completely rewritten, enlarged and brought up to date, and a chapter added on airplane engines to cover all five types of these motors. Every type of gasoline and heavy-oil engine used in the United States Navy, including those used on submarine chasers and naval launches, the Diesel and Standard types, is described.

The subject is divided into twelve chapters, taking up in order fuels, solid, liquid and gaseous; comparison of internal-combustion, and steam engines; construction; types, cycles, etc.; carburetion, the mixture, its preparation, carburetors and vaporizers; ignition and ignition systems; cooling and lubrication; governing and indicator cards; operation, troubles and remedies; gasoline, kerosene and alcohol engines, aërial motors; the Diesel, Nürnberg and Sulzer types of engines.

The work is not a book on design, but it gives a practical description of the construction and operation of the different types of internal-combustion engines. The practical way in which the subject is presented both in text and illustrations makes the work easily understood even by the uninitiated, and it should meet with favor from all those who are interested in internal-combustion engines.

TESTING CURRENT TRANSFORMERS

The Bureau of Standards has recently issued Scientific Paper No. 309, entitled "A Method for Testing Current Transformers." A general method is outlined in this paper for the determination of the ratio and phase angle of current transformers in terms of the constants of previously calibrated standard transformers of the same nominal ratio. It has been shown that such methods are essentially more sensitive or, conversely, may be used with much less sensitive instruments than the laboratory methods now in use for the absolute determination of the ratio and phase angle of a single transformer. Two of the most convenient of the many possible modifications of the general method are described in detail. It is hoped that the methods will be found useful in commercial plants where delicate laboratory equipment is not available and where large numbers of transformers must be tested rapidly and with moderate accuracy. This paper is now available for distribution, and those interested may obtain a copy by addressing a request to the Bureau of Standards, Washington, D. C.

Obituary

F. G. Rollins, late president of the Holmes Metallic Packing Co., of Wilkes-Barre, Penn., died at his home in Philadelphia on Feb. 20, in his 57th year. He is survived by his wife, mother and one sister.

Personals

J. C. Bertsch has resigned his position as refrigerating engineer with the Westinghouse Electric and Manufacturing Co. Machine Works, to become established as general consulting engineer, with offices in the Monongahela Bank Building, Pittsburgh, Penn.

W. H. Thompson, for many years prominent in the heavy electric-traction work of the Westinghouse Electric and Manufacturing Co., has resigned to accept the position of works manager of the Fairmont Mining Machinery Co., Fairmont, W. Va., makers of coal-mining equipment.

W. C. Austin, auditor of the Eastern Pennsylvania Railways Co., Pottsville, Penn., has been elected assistant secretary and assistant treasurer of that company. In 1917 Mr. Austin was transferred from the staff of traveling auditors of the J. G. White Management Corporation, New York, to the accounting department of the Eastern Pennsylvania Railways Co., which company is being operated by the Management Corporation.

Engineering Affairs

The Arkansas Association of Public Utility Operators will hold a state convention at Hot Springs, Ark., May 21-23, with headquarters at the Arlington Hotel.

The Engineering Council's first annual meeting was held Feb. 21. The following officers were elected: Chairman, J. Parke Channing; first vice chairman, Harold W. Buck; second vice chairman, George F. Swain; secretary, Alfred D. Flinn. Committees were appointed as follows: Executive committee, the chairman, the two vice chairmen and David S. Jacobus, Calvert Townley, George J. Foran; finance committee, E. Wilbur Rice, Jr., chairman; Charles F. Loweth, Sidney J. Jennings, David S. Jacobus; rules committee, J. Parke Channing, chairman; Clemens Herschel, Nathaniel A. Carle, Irving E. Moultrop; public affairs committee, Charles Whiting Baker, chairman; George F. Swain, Benjamin B. Thayer, E. W. Rice, Jr., Charles E. Skinner. American engineering service, George J. Foran, chairman; George C. Stone, Alfred D. Flinn, Dr. Addams S. McAllister, Edward B. Sturgis, secretary; war committee of technical societies, D. W. Bruntno, chairman; Arthur H. Storrs, secretary; James M. Boyle, Nelson P. Lewis (American Society of Civil Engineers), Edmund B. Kirby (American Institute of Mining Engineers), A. A. Greene, Jr., R. N. Inglis (American Society of Mechanical Engineers), Harold W. Buck, Dr. Addams S. McAllister (American Institute of Electrical Engineers), Dana D. Barnum, E. C. Uhlig (American Gas Institute), Joseph Bijur, Dr. Charles A. Doremus (American Electrochemical Society), Louis B. Marks, Preston S. Milar (Illuminating Engineering Society), Christopher R. Corning, George C. Stone (Mining and Metallurgical Society of America), Henry Torrance, F. E. Matthews (American Society of Refrigerating Engineers); fuel conservation committee: L. P. Breckenridge, chairman; Ozni P. Hood, secretary; Robert H. Fernald, Charles R. Richards, Charles L. Edgar, Carl Scholz, David Moffat Myers, Edwin Ludlow, Harold W. Buck.

The definition of the Engineering Council that was adopted declared that "the Engineering Council is an organization of national technical societies of America created to provide for consideration of matters of common concern to engineers, as well as those of public welfare in which the profession is interested, in order that united action may be made possible. The Engineering Council is now composed of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, having a membership of 33,000 and known as the 'Founder Societies.'"

Miscellaneous News

A Boiler Exploded on the Croffett plantation, near Bastrop, La., on Feb. 12, injuring two persons, one perhaps fatally, and wrecking the entire machinery.

A Boiler Tube Blew Out at the plant of the Sioux City (Iowa) Gas and Electric Co. on Feb. 8, injuring two firemen, one seriously. The accident necessitated shutting off the power until repairs were made.

Urges Higher Compensation for Engineers—At the conference in Washington Feb. 26, between representatives of capital and labor, held to forward the adoption of a national labor policy, a representative of the Engineering Council urged the necessity of higher compensation for engineers, to enable them to take their proper part in the nation's activities in war and peace.

An Order Authorizing the construction of a power dam at Muscle Shoals, Ala., has been signed by President Wilson, as part of the $60,000,000 project for the erection of a Government plant there for the fixation of atmospheric nitrogen for use in the manufacture of munitions and fertilizer. The site has been offered to the government without cost by the Alabama Power Co.

The Schütte & Koerting Co., of Philadelphia, has been taken over by the United States Government as an alien concern. It will be operated by A. Mitchell Palmer, alien property custodian. Adalbert Wilhelm Fischer, its former president, is now interned as a dangerous enemy alien. His wife is the daughter of Ernest Koerting, of Hanover, Germany, believed to be a near relative of the German Emperor.

An Economizer Exploded recently at the plant of the Ithaca Traction and Lighting Co., Renwick, N. Y. From an investigation of the circumstances under which the accident occurred, it develops that the economizer had been shut off from the line and the bypass used without shutting the dampers leading to the economizer, these dampers having been warped so they could not be operated. The engineer who was responsible for the explosion was instantly killed.

Business Items

C. W. Hunt Co., Inc., has moved its New York offices from 45 Broadway to the Astor Trust Building, 501 Fifth Avenue.

The H. W. Johns-Manville Co. is now comfortably installed and working full speed in its new building at St. Louis, Mo., on the southeast corner of Olive and 11th Streets.

The Cleveland (Ohio) Electric Illuminating Co. is planning on building a two-story and basement addition to its present power station on East 70th St., at a cost of about $1,000,000. A 25,000-kw. turbine will be installed.

The Westinghouse Electric and Manufacturing Co. announces the removal of its office from Phoenix, Ariz., to Tucson, Ariz. Its representatives, J. H. Knost and W. G. Willson, will have headquarters in the Immigration Building at the latter point.

The Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., has recently secured the exclusive sales agency for the United States for Frankel solderless connectors, widely used for joining electrical wires and cables. The Westinghouse company will act also as a distributor of Frankel testing clips.

Trade Catalogs

Safety Auto-Lock Switches. Krantz Manufacturing Co., Inc., Brooklyn, N. Y. Special publication No. 1585-A. Pp. 4; 8 x 11 in.; illustrated. Describes a type of safety switch manufactured by this company and also gives list prices.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Feb. 28, 1918	One Year Ago	Feb. 28, 1918	One Year Ago
Buckwheat	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	.....	.....	.....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Feb. 28, 1918	One Year Ago	Feb. 28, 1918	One Year Ago
Clearfields	.....	$3.00	.....	$4.25—5.00
Cambrias and Somersets	.....	3.10—3.85	.....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Feb. 28, 1918	One Year Ago	Feb. 28, 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$7.25—7.50
Buckwheat	4.30—5.00	2.75	5.50—5.80	7.00—7.25
Barley	3.25—3.50	1.95	4.00—4.25	4.00—4.25
Rice	3.75—3.95	2.20	4.50—4.80	5.00—5.50
Boiler	3.50—3.75	2.20	.....	3.50—4.00

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Feb. 28, 1918	One Year Ago	Feb. 28, 1918	One Year Ago
Pea	$3.75	$2.80	$4.65	$3.70
Barley	2.15	1.85	2.40	2.05
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.10	3.65	3.00
Boiler	2.45	1.95	3.55	3.15

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Feb. 28, 1918	One Year Ago	Feb. 28, 1918	One Year Ago	Feb. 28, 1918	One Year Ago
6-in. lump	$2.65-2.80	$3.25-3.50	$2.65-2.80	$3.25-3.50	$2.65-2.80	$2.50-2.75
2-in. lump	2.65-2.80	.....	2.65-2.80	.....	2.65-2.80	.....
Steam egg	2.65-2.80	.....	2.65-2.80	.....	2.65-2.80	.....
Mine-run	2.40-2.55	2.75-3.00	2.40-2.55	3.00	2.40-2.55	2.25-2.50
No. 1 nut	2.65-2.80	3.25-3.50	2.65-2.80	3.25-3.50	2.65-2.80	2.35-2.75
2-in. screen	2.15-2.30	2.50-2.75	2.15-2.30	2.75-3.00	2.15-2.30	2.25-2.50
No. 5 washed	2.15-2.30	3.00	2.15-2.30	2.75-3.00	2.15-2.30	2.50

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba	2.40	2.65	2.15

Government figures.

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Calif., Ontario—The San Antonio Water Co. plans to build a power plant in the San Antonio Canyon. G. D. Smith, Mgr.

Fla., Wauchula—City plans an election soon to vote on $25,000 bonds for the erection of an electric-lighting plant.

Ga., Montezuma—J. Harrison and E. M. McKenzie are considering plans for the installation of a hydro-electric plant on Whitewater Creek, 4 miles from here.

Ill., Jacksonville—The Board of Education plans to build a boiler house.

Iowa, Lorimor—The Lorimor Light and Power Co. has been granted a franchise by the Board of Commissioners, to build and operate an electric transmission line in Union Co.

Iowa, Maquoketa—The Iowa Electric Co. plans to extend its 33,000-volt transmission line from here to Anamosa. J. I. Reed, Gen. Mgr.

Iowa, Waterloo—The Citizens Gas and Electric Co. has been granted a franchise by the Board of Railroad Commissioners, to build and operate an electric transmission line. H. B. Maynard, Secy.

Md., Monkton—The Monkton Roller Mills Co. plans to build a hydro-electric power plant on Gunpowder River to operate a proposed flour mill. Estimated cost, $25,000. O. E. McCoy, Mount Washington, Pres.

Mich., Marquette—City is in the market for a waterwheel and a generator to cost about $45,000, in connection with the new electric power plant. C. Retallic, Supt. T. W. Orbison, Consult. Engr.

Minn., Nashwauk—City plans to install a new electric deep well pump. Estimated cost, $7,000.

N. Y., Buffalo—The Eastern Monolithic Co., 96 South Park Ave., is in the market for electric motors.

N. Y., Greenwich—The Consolidated Electric Co. has petitioned the Public Service Commission for authority to build a 3 mi. transmission line from Northumberland Bridge through Bacon Hill and along highway leading from Bacon Hill to Grangeville. H. C. Gray, Mgr.

N. Y., Utica—The Savage Arms Corporation, Turner St., is in the market for 1000 hp. power plant equipment. Noted July 31.

N. C., Raleigh—The Empire Steel Co. plans to build a hydro-electric plant to operate its steel plant which will be equipped with electrically driven machinery.

N. D., Nome—City plans to install an electric-lighting plant.

Ohio, Cleveland—The Cleveland Electric Illuminating Co., Public Sq., is in the market for 25,000 kw. turbine and accessory equipment. Noted July 31.

Okla., Okemah—City has plans under consideration for the erection of an electric-lighting plant.

Okla., Shattuck—City plans to install either an oil fuel or steam plant for power. J. C. Fowler, Secy., Chamber of Commerce.

Okla., Stillwater—City plans an election soon to vote on $175,000 bonds for improvements to its electric-lighting plant, etc. G. M. Smith, Supt.

Tex., Grapevine—The Grapevine Light and Ice Co. plans to build a new plant soon. Burrough & Harmon, Owners.

Utah, Monticello—The Blye Mountain Irrigation Co. has increased its capital stock from $15,000 to $16,000; the proceeds will be used to improve and extend its transmission line.

Utah, Provo—S. P. Stewart has applied to the State Engineer for permission to take 10 second feet of water for the electric generating plant to be erected here.

Wash., La Grande—The American Nitrogen Products Co. plans to install 3 electric ovens in its plant.

Wash., Seattle—The Board of Public Works will receive bids until March 15, instead of March 1, for the erection of a hydro-electric power plant. Estimated cost, $5,000,000. J. D. Ross, Supt. of Light and Power. Noted Feb. 8.

W. Va., Charleston—The State University plans to rebuild its boiler house which was recently destroyed by fire.

Wis., Appleton—The Patton Paper Co. plans to build a hydro-electric power plant. J. McNaughton, Pres.

Wis., Kilbourn—The Wisconsin Power, Light and Heat Co., Milwaukee, has purchased the property of the Omro Electric Light Co., Omro, and plans to extend its Kilbourn and Price due Sac transmission lines to Berlin and Omro. J. I. Beggs, 1428 1st Natl. Bank Bldg., Milwaukee, Pres.

Wyo., Wheatland—The Town is in the market for a 150 hp. engine with a 100 kw.a. generator.

Ont., Beeton—City plans to issue $15,000 bonds for the installation of a hydro-electric system.

Ont., Toronto—The Swift Canadian Co., Keel St. and St. Clair Ave., plans to build a concrete and brick addition to its boiler house. Estimated cost, $10,000.

Ont., Tottenham—City plans to install a hydro-electric system here.

Prices—Materials and Supplies

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

ELECTRICAL SUPPLIES

KNIFE SWITCHES—Following are net prices each in cities named for knife switches mounted on slate base, front connected, punched clip type, 250 volts:

	30 Amp.	60 Amp.	100 Amp.	200 Amp.
D. P. S. T. fuseless	$0.52	$0.93	$1.90	$3.42
D. P. S. T. fused	.81	1.37	2.70	5.14
D. P. D. T. fuseless	.88	1.52	3.42	5.70
D. P. D. T. fused	1.67	2.58	5.62	9.88
T. P. S. T. fuseless	.78	1.40	2.86	5.14
T. P. S. T. fused	1.32	2.05	4.18	7.70
T. P. D. T. fuseless	1.37	2.35	5.24	8.82
T. P. D. T. fused	2.68	4.13	8.99	15.80

Lots $25 and more, list.

FUSES—Following are net prices of 250-volt inclosed fuses each, in standard packages, in cities named:

0-30 amperes	$0.11¼ each	110-200 amperes	$0.90 each
31-60 amperes	.15¾ each	225-400 amperes	1.62 each
61-100 amperes	.40 each		

FUSE PLUGS (MICA CAP) PER 100

0-30 amperes.. 4c. each in standard package quantities (500)
0.30 amperes.. 5c. each for less than standard package quantities (500)

SOCKETS, B. B. FINISH—Following are net prices in cents each in standard packages:

⅛-IN. OR PENDANT CAP			⅜-IN. CAP		
Key	Keyless	Pull	Key	Keyless	Pull
22.10c.	21.00c.	42.00c.	27.30c.	26.20c.	46.20c.

Note—Less than standard package quantities, 15% off list.

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S. B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	....
T. P. S. B.	.81	1.80	....
D. P. D. B.	.78	2.10	....
T. P. D. B.	1.35	3.60	....
T. P. to D. P. D. B.	.90	2.52	....

ATTACHMENT PLUGS—Price each, in standard packages:

		Standard Package
Hubbell porcelain	$0.21	250
Hubbell composition	.12	50
Benjamin swivel	.12	100
Current taps	.35	50

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$21.50
No. 16 cotton twisted	29.00
No. 18 cotton parallel	24.00
No. 16 cotton parallel	36.00
No. 18 cotton reinforced heavy	28.50
No. 16 cotton reinforced heavy	39.40
No. 18 cotton reinforced light	24.00
No. 16 cotton reinforced light	32.00
No 18 cotton Canvasite cord	21.75
No. 16 cotton Canvasite cord	32.00

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York:

No.	Solid. Single Braid	Solid. Double Braid	Stranded. Double Braid	Duplex
14	$10.50	$12.50	$15.00	$23.50
12	14.23	16.92	19.48	32.25
10	16.92	22.83	25.81	45.00
8	27.65	31.40	35.50	61.00
6	....	....	56.00	....
4	....	....	76.40	....
2	....	....	112.45	....
1	....	....	152.26	....
0	....	....	182.90	....
00	....	....	228.60	....
000	....	....	271.24	....
0000	....	....	332.40	....

COPPER WIRE—Prices per 1000 ft. for rubber-covered wire in following cities:

	Denver			St. Louis			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$10.90	$15.15	$27.25	$13.50	$16.25	$31.25	$13.50	$16.25	$31.25
10	23.70	27.05	49.35	25.00	28.50	56.40	25.00	28.50	56.40
8	33.60	37.35	74.45	34.85	38.85	74.70	34.85	38.85	74.70
6	....	57.15	....	59.75	64.25	....	59.75	64.25	....
4	....	81.70	....	84.40	84.90	....	84.40	84.90	....
2	....	121.80	....	125.50	132.00	....	125.50	132.00	....
1	....	158.50	....	163.00	171.15	....	163.00	171.15	....
0	....	189.40	....	216.00	225.00	....	216.00	225.00	....
00	....	298.05	....	263.00	273.50	....	263.00	273.50	....
000	....	362.15	....	320.00	331.50	....	320.00	331.50	....
0000	....	448.50	....	388.50	400.50	....	388.50	400.50	....

LOOM—Price per 100 ft., in coils:

	Ft. in Coil			Ft. in Coil	
¼	250	$2.25	¾	150	$7.00
⅜	250	3.50	1	100	10.00
½	200	4.50	1¼	100	12.00
⅝	200	5.75	1½	100	15.00

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per unit for elbows and couplings:

	Conduit		Elbows		Couplings	
In.	Enameled	Galvanized	Enameled	Galvanized	Enameled	Galvanized
½	$69.70	$74.80	$0.1672	$0.1786	$0.0616	$0.0658
¾	92.00	98.90	.22	.235	.088	.094
1	136.00	146.20	.3256	.3478	.1144	.1222
1¼	184.00	197.80	.4185	.4496	.1581	.1698
1½	220.00	236.50	.558	.5994	.1953	.2098
2	296.00	318.20	1.023	1.10	.2604	.2797
2½	468.00	503.10	1.674	1.80	.372	.3996
3	612.00	657.90	4.464	4.79	.558	.5994
3½	763.60	818.80	9.86	10.59	.744	.7992
4	926.50	991.90	11.39	12.23	.93	.999

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

LOCKNUTS AND BUSHINGS—Following are net prices in standard packages, which are: ½-in., 1000; ¾- to 1¼-in., 100; 1½- to 2-in., 50:

	Locknuts Per 100	Bushings Per 100	Flexible Conduit Box Connections Per 100
½	$1.02	$1.68	$5.62
¾	1.75	4.00	7.12
1	3.00	6.15	10.50
1¼	5.00	8.20	15.00
1½	7.50	10.25	22.50
2	10.00	16.40	30.00
2½	12.30	24.60	67.50

ARMORED CABLES AND BOX CONNECTORS—Following are net prices per 1000 ft. cable and standard package of 100 box connectors in single and double strip:

Wire Gage	Twin Conductor Cable	Twin Conductor Connectors	Three Conductor Cable	Three Conductor Connectors
14	$65.00	$4.50	$103.50	$4.50
12	101.25	4.50	127.50	4.50
10	138.75	4.75	176.25	4.75
8	176.20	5.75	247.50	6.00
6	277.50	6.25	362.40	7.50
4	431.25	7.50	....	....

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B— Watts	Plain	Frosted	No. in Package	Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.30	$0.33	100	75	$0.70	$0.75	50
15	.30	.33	100	100	1.10	1.15	24
25	.30	.33	100	150	1.65	1.70	24
40	.30	.33	100	200	2.20	2.27	24
50	.30	.33	100	300	3.25	3.35	24
60	.35	.39	100	400	4.30	4.45	12
100	.70	.77	24	500	4.70	4.85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

WIRING SUPPLIES—New York prices for tape and solder are as follows:

Friction tape, ½-lb. rolls	35c. per lb.
Rubber tape, ½-lb. rolls	45c. per lb.
Wire solder, 50-lb. pools	45c. per lb.
Soldering paste, 1-lb. cans	50c. per lb.

FANS—It is prophesied that there will be a scarcity of electric fans this summer.

MISCELLANEOUS

HOSE—

Fire

	50-Ft. Lengths
Underwriters' 2½-in.	75c. per ft.
Common, 2½-in.	40%

Air

	First Grade	Second Grade	Third Grade
¾-in. per ft.	$0.55	$0.30	$0.25

Steam—Discounts from list

First grade... 30% Second grade... 30-5% Third grade... 40-10%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition ..... 50% Best grade 20%
Standard 35%

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	40%	35%
St. Louis	45%	40%
Chicago	30+10%	40+5%
Birmingham	35%	35%
Denver	40%	35%

RAWHIDE LACING—40%.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.90
Asbestos for high-pressure steam	1.30
Duck and rubber for piston packing	1.00
Flax, regular	.90
Flax, waterproofed	1.10
Compressed asbestos sheet	1.00
Wire insertion asbestos sheet	1.20
Rubber sheet	.60
Rubber sheet, wire insertion	.90
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.10
Asbestos wick, ½- and 1-lb. balls	.70

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.90	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure ..... 5% off

For low-pressure heating and return lines { 4-ply ..... 58% off; 3-ply ..... 60% off; 2-ply ..... 62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	7	5½	6.1	7½	10
Fiber or sponge	8	6	6.4	15	15
Transmission	7	6	6.4	10	15
Axle	4½	4	3.3		5
Gear	4½	4½	6.5	7½	6
Car journal	22 (gal.)	3½	4.6	5	6

COTTON WASTE—The following prices are in cents per pound:

	New York			
	Feb. 28, 1918	One Year Ago	Cleveland	Chicago
Colored mixed	8.50 to 12.00	10.00 to 12.00	12.50	12.00 to 12.50
White	11.00 to 13.00	13.00 to 15.00	16.00	10.00 to 11.00

WIPING CLOTHS—In Cleveland the jobbers' price per 1000 is as follows:

13¼ x 13½ ..... $45.00 13¼ x 20½ $52.00

In Chicago they sell at $30@33 per 1000.

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Feb. 28, 1918	1 Year Ago	Feb. 28, 1918	1 Year Ago	Feb. 28, 1918	1 Year Ago
Raw per barrel	$1.36	$0.90	$1.35	$1.00	$1.35	$0.98
5-gal. cans	1.46	1.09	1.50	1.10	1.45	1.08

WHITE AND RED LEAD in 500-lb. lots sell as follows in cents per pound:

	Red				White			
	Feb. 28, 1918		1 Year Ago		Feb. 28, 1918		1 Yr. Ago	
	Dry	In Oil	Dry	In Oil	Dry and In Oil		Dry and In Oil	
25- and 50-lb. kegs	11.50	11.00	10.50	11.00	10.50		10.50	
12½-lb. keg	11.75	11.25	10.75	11.25	10.75		10.75	
100-lb. keg	11.25	11.50	11.00	11.50	11.00		11.00	
1- to 5-lb. cans	13@25	13.00	12.50	12.50	13.00		12.50	

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	30%	35%	40%*
Tinned	30%	35%	40%*

*For less than keg lots the discount is 35%.

Button heads, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York ..... $7.00 Cleveland ..... $5.85 Chicago $5.50

Coneheads, same sizes:

New York ..... $7.10 Cleveland ..... $5.95 Chicago $5.60

FIRE BRICK—Quotations on the different kinds in the cities named are as follows, f.o.b. works:

	New York	Chicago
Silica brick, per 1000	$50.00 to 55.00	$50.00
Fire clay brick, per 1000, No. 1	45.00 to 55.00	.....
Magnesite brick, per net ton	135.00 to 145.00	.....
Chrome brick, per net ton	135.00	.....
Deadburned magnesite brick, per net ton	85.00 to 90.00	.....
Special furnace chrome brick, per net ton	60.00 to 70.00	60.00 to 80.00

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—High grade, $55 to $65; St. Louis grade, $40 to $50.
Birmingham—Fire clay, $25 to $30; Denver, $23, per 1000.
Chicago—Second quality, $25 per ton.

FUEL OIL—Price variable, depending upon stock. New York quotations not available owing to this fact. In Chicago and St. Louis the following prices are quoted:

	Chicago	St. Louis
Domestic light, 22-26 Baumé	5c.	None
Mexican heavy, 12-14 Baumé	7c.	7½c.

Note—There is practically no fuel oil in Chicago at present time.

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Feb. 28, 1918	One Year Ago
New York	$15.00	$8.00
Cleveland	15.30	7.50
Chicago	15.00	6.00

In coils an advance of 50c. usually is charged.
Note—Stock very scarce generally.

POLES—Prices on Western red cedar poles:

	New York	Chicago	St. Louis	Denver
6 in. by 30 ft.	$5.59	$4.94	$4.94	$4.32
7 in. by 30 ft.	7.40	6.60	6.60	5.80
7 in. by 35 ft.	10.70	9.60	9.60	8.55
8 in. by 35 ft.	12.20	10.90	10.90	9.65
7 in. by 40 ft.	12.35	11.00	11.00	9.75
8 in. by 40 ft.	13.75	12.15	12.15	10.65
8 in. by 45 ft.	18.20	16.20	16.20	14.30
8 in. by 50 ft.	21.85	19.45	19.45	17.15

10c. higher freight rates on account of double loads.

For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft.	$6.00
12-in. butts, 6-in. tops, length 30-40 ft.	8.50
12-in. butts, 6-in. tops, length 41-50 ft.	9.50
14-in. butts, 6-in. tops, length 51-60 ft.	17.00
14-in. butts, 6-in. tops, length 61-71 ft.	18.50

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh, basing card in effect July 2, 1917, for iron, and May 1 for steel:

BUTT WELD

Steel			Iron		
Inches	Black	Galvanized	Inches	Black	Galvanized
¼ to 3	49%	35½%	¼ to 1½	33%	17%

LAP WELD

2	42%	29½%	2	26%	12%
2½ to 6	45%	32½%	2½ to 4	28%	15%
7 to 12	42%	28½%	4½ to 6	28%	15%
13 and 14	32½%	....	7 to 8	20%	8%
15	30%	....			

BUTT WELD, EXTRA STRONG PLAIN ENDS

¾ to 1½	47%	34½%	¾ to 1½	35%	18%
2 to 3	48%	35½%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	40%	28½%	2	27%	14%
2¼ to 4	43%	31½%	9 to 12	15%	3%
4½ to 6	42%	30½%	7 to 12	25%	12%
7 to 8	38%	24½%	2½ to 4	29%	17%
9 to 12	33%	19½%	4½ to 6	28%	16%

From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	38%	42%	34.27%
3½ to 6 in. lap welded	18%	38%	21.27%
7 to 12 in. lap welded	10%	35%	21.27%

	Galvanized		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	22%	22%	19.27%
3½ to 6 in. lap welded	List	18%	13.27%
7 to 12 in. lap welded	List+20%	20%	6.27%

Malleable fittings, Class B and C, from New York stock sell at 5 and 5% from list prices. Cast iron, standard sizes, 34 and 5%.

BOILER TUBES—The following are the prices for carload lots f.o.b. Pittsburgh, announced Nov. 13, as agreed upon by manufacturers and the Government:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	34	3½ to 4½ in.	12½
2½ to 3¼ in.	24	3 to 3¼ in.	+ 5
2¼ in.	17½	2½ to 2¾ in.	+ 7½
1¾ to 2 in.	13	2 to 2¼ in.	+22½
		1¾ to 1⅞ in.	+35

Standard Commercial Seamless—Cold drawn or hot rolled:

Per Net Ton		Per Net Ton	
1 in.	$340	1¾ in.	$220
1¼ in.	280	2 to 2½ in.	190
1⅜ in.	270	2¾ to 3¾ in.	180
1½ in.	220	4 in.	200
		4½ to 5 in.	220

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation.